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SCHOOL SCIENCE AND MATHEMATICS

VOL. XXXI No. 8 NOVEMBER, 1931 WHOLE No. 271

"SAUVEZ DES ELITES"

Have you received a letter from a friend in France recently? The French postal department now stamps all mail with this slogan, "Save the Best." It is a good motto. France looks far into the future. Her leaders of tomorrow are in the schools today. She cannot afford to stunt her future leaders by depriving them of any of the advantages and opportunities open to the boys and girls of other countries. She is not cutting educational budgets as a part of any economy plan.

No more can America afford to curtail her educational program. Short-sighted polititians and taxpayers are clamoring for economies, but instead of concentrating on elimination of graft and waste, in some cases they are taking the easier course of cutting the appropriations for essentials. Here is the place where teachers must fight to hold the ground gained by years of struggle. All attempts to increase size of classes, cut appropriations for equipment or curtail essential activities should be resisted with all force. Teachers must lead the defense. They are the elected guardians of public education. The fight should be carried direct to the people. Every parent will be on the side of education when he fully understands the situation. Taxpayers have good reason for complaint but in most cases public education is not the cause. Teachers need to help investigate the true causes and bring them forceably before the community. The teacher's task is not finished when the school day is ended. Parents need education also and they will gladly

accept it if they find a real educator and leader willing to help. Teachers, it is up to you to get the parents all pulling with the schools.

MEDIOCRITY MUST GO

Leaders with vision are now planning additional expenditures to improve educational practices and proceedures. Next September Teachers College, Columbia University, will open a new school for the definite purpose of selecting a few of the best from all over the country to become teachers. The teaching profession cannot afford to take left-overs. A part of the Columbia plan is to train as many men as women to become teachers. It is believed that teaching should be a profession for men as well as for women. The student body for the first year will be limited to 100 men and 100 women. Unusual care will be taken to select young people of outstanding ability and personality. The faculty for this college will be as carefully selected as the student body. Every member of the faculty must be a real teacher. Here is a worthy project.

OUR MOST IMPORTANT INDUSTRY.

In September 25,000,000 children started a new school year in the elementary and public high schools of the United States. 1,500,000 young men and women registered in college and university. Other enrollments in public and private schools raised the grand total to about 31,000,000, more than one-fourth of the Nation's population. 850,000 teachers are employed. A quarter million school buildings are in use.

No other industry can compare in the number directly engaged. No other industry directly interests so many people. No industry has so great an opportunity nor responsibility. The teacher is a more important and influential officer than any department head that can be found in any other industry. A young man or woman accepts this responsibility on entering the profession. It should be constantly kept in mind by everyone. Scholarship is important but character comes first in the list of desirable attainments.

HOW THE MIDDLE AGES COUNTED

By Bernadette M. Larney,
Marygrove College, Detroit, Mich.

Since the beginning of time man has ever sought to bring into subjection the natural forces surrounding him that he might accomplish his purpose more easily, more accurately or more swiftly. Nowhere is this desire so clear as in his endeavor to develop some mechanical or material mechanism to perform those operations he employs either in counting or measuring. To this end he has used many devices ranging from primitive finger computation and "pacing-off" to the latest complex electric bookkeeping machine or modern alti-meter. Perhaps the most interesting of these are the primitive instruments used by man, but so shrouded in the twilight of the race are these beginnings, that they are entirely beyond the novice and amateur mathematician. The mediaeval period however, furnishes a fertile field for those interested in mathematical instruments that are not too obscure nor too complicated in construction to be understood. At that time man had to a great extent conquered nature as he knew it, and had discovered most of the elementary principles of mathematics. He was, therefore, seeking means to make applications of these principles swifter and easier. He had at hand a number of primitive instruments which had originated much earlier. These he developed and perfected to meet his needs. As his knowledge and experience increased, he invented new types and improved the old. In the middle ages, therefore, we find the lineal descendants of the instruments used by the ancients and the direct predecessors of the exquisitely precise and extremely complicated mechanisms we use today.

The devices used for calculation, that is for performing any of the fundamental operations, fall into four distinct classes: finger notation and calculation; knotted cords; tallies; and the abacus. While the use of the abacus required some modicum of education or training, the first three methods were common to practically all classes of people, even the most unlettered. The humblest peasant was conversant with these types, and though multiplication and division were for the most part beyond him, he very fre-

quently attained considerable skill in rapid addition and subtraction.

Finger notation is, of course, the simplest and the most primitive of these. Unquestionably it is the oldest. That the ten fingers are a natural counting device is evidenced by the child's instinctive "counting-off" on his fingers. Evidence of this sort of counting is found in all races. As man became more civilized, however, his fingers became a veritable machine for calculation. The hand in a certain position with the fingers held in a prescribed manner, indicated a number. By means of what seem to us very complicated rules, man could not only add and subtract but multiply and divide. Indeed in some sections of China today intricate bargaining can be carried on for hours in perfect silence, by employing the fingers for symbols and calculations. The Venerable Bede gives us the most complete description of finger notation and computation as it existed among the English. We quote his description in part:

> The reckoning is made first on the left hand, as follows: When you say One, bend the little finger of the left hand, and place it on the middle of the palm. When you say Two, bend the fourth finger and place it likewise. When you say Three, do the same with the third finger. When you say Four, raise the little finger again. For Five raise the fourth finger, for Six raise the middle finger, keeping the fourth finger, which is called Medicius, fixed on the palm. When you say, Seven, place the little finger only (the rest being raised), above the root of the palm. When you say Eight, place the fourth finger beside it, when Nine, the third. When you say Ten, put the tip of the first finger on the middle joint of the thumb.[1]

Bede gives about ninety symbols in all, one for twenty, thirty, forty, etc., one hundred, thousand, and the symbol of one million. . . . "When you say a million, you clasp your hands with the fingers interlocked in a loving embrace." He then gives various rules whereby the fingers may be employed for calculations.

The foregoing passage precedes a discourse on how to reckon time which was frequently computed on the fingers long after their use for other computation had been discarded. It was an ancient custom and has given rise to many interesting expressions. Since the figuring usually began on the left hand, the figures on the right hand ran into hundreds, and the right hand, therefore, was connected with longevity. Thus we have in the Book of Proverbs

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[1]Translation from Florence Yeldham, *Reckoning in the Middle Ages*, p. 30.

the beautiful line, "She comes with length of days in her right hand." Juvenal says, "Happy is he indeed who has postponed the hour of his death so long and finally numbers his years upon his right hand." Pliny avers that King Numa had the statue of Janus cast so that the hands indicated the number of days in a year.

Another interesting peculiarity of finger computation may be here noted. Though most civilized races count to the base ten, the highly civilized Mayas of Yucatan, and the semi-civilized tribes of the North American Indian count to the base twenty, since, going barefoot, they used both fingers and toes.

Closely related to finger reckoning was the method whereby man kept a permanent record of his calculations by tying knots in a cord. This also is of very ancient origin. Lao-tze in the sixth century B. C. says in the Tao-teh-king: "Let the people return to knotted cords and use them," indicating that even at that time the method had been commonly used and had already been superseded by another. They were used extensively throughout the middle ages, especially when the number indicated by the knots was to be used again, as the rosary which counted the number of prayers to be recited for a special devotion, or the record of the number of sheep in a flock. This form of counting is admirably illustrated in the New World by the Peruvian quipu, an instrument of considerable utility and complexity.

The quipu was a short length of cord to which were attached pendant cords. Knots in the main thong frequently indicated the number of subsidiary cords and as frequently, the sums of the pendant cords. The apparent perfection of these quipus and the high state of civilization prevalent in the people who used them have made the Peruvian knot-records an object of great interest to the archeologist as well as to the mathematician. It has been conjectured that they might have been used for historical records; that the various types and grouping of the knots were used to convey ideas, not merely numbers; that the colors used in the thongs were not without meaning; and that the distribution and distance from the main thong each had its peculiar significance. Leslie Leland Locke,[3] who has made an extensive

[3] "The Ancient Quipu," *American Anthropologist*, XXIV, p. 330.

study of this instrument, maintains that the quipu was used for numerical purposes only. He believes the color scheme had no special meaning, but was dictated, probably, by the taste of the maker. He says, however, that we cannot say definitely that the colors did not have a significance among the people who used them. The groupings are mere aggregations of units, one knot for one, two knots for two, and so on, up to nine. The larger knots indicated tens, while the distance from the main thong seems to have shown hundreds, thousands, etc.

This same device in a less perfect form is found among the American Indians who put it to one very amusing use. Frequently when one tribe invited another to a ceremony, the messenger was supplied with a cord containing a number of knots equal to the number of days which would elapse before the event. The guests could then insure their timely arrival by removing a knot for each day that passed. This method of counting is still used among the Santal Indians. When the census is taken by the headman, he simply puts a knot in a black cord for each adult man, in a red cord for each adult woman, and in white and yellow cords, respectively, for boys and girls. He then has the whole population recorded on four strings!

Similar to the quipu is the tally stick. This is a short, flat piece of wood, notched to represent the number to be recorded. It was used in the Orient long before the advent of the suanpan. Little bamboo rods called sangi were employed by the Chinese in this manner. These Chinese tallies were adopted by the Japanese and Koreans and are found among them, to some extent, today. A box of sangi forms an essential part of the Korean schoolboy's equipment. With them he can perform many complicated operations, even solving algebraic equations. They were used widely in the middle ages for counting and recording. If a shepherd wished to number his sheep he drove them through a narrow gate. As they passed in one's and two's, he made a notch on his tally for each. But these little sticks had other possibilities than that of one to one correspondence. Vera Sanford in her History of Mathematics says:

> In the northern countries (England, Germany, the Netherlands) bookkeeping was managed by tally sticks. The tallies were flat pieces of wood in which sums of money were indicated by notches, the length

indicating the amount of money. The tally was then cut through the notches, the debtor keeping one part, the creditor the other.[3]

This device has left many traces in our language. From the root of the word itself, the French "tailler" (to cut), we get our "tailor." We have many other common expressions from it such as: "to keep tally," "to tally up," "our accounts tally." It appears frequently in the literature of the time. Chaucer describes the Maunciple as one

". . . wyse in buying of vitaille
For whether that he payed, or took by taille
Algate he wayted, so in his aschat
That he was ay biform and in good estat."[4]

Piers plowman speaking of his gold, says that he "toke it by taille," meaning by count. And we have "taillage" for toll or tax, the first poll tax levied by the English Parliament being the "tailage of groats" in 1377, a relic of the days when "our forefathers had no other books but the score and the tally."[5] The expression "to hold stock in a company" arose from the custom in the early days of the Bank of England to issue receipts in the form of tallies, the Bank keeping the smaller stick or "foil," while the depositor kept the larger or "stock." Thus he became a "stock-holder."

The tally was used in the British Treasury until 1826. The accumulated accounts of many years were then burned —a process which incidentally demolished two Parliament buildings. This piece of British conservatism has been satirized by Dickens:

Ages ago a savage mode of keeping accounts on notched sticks was introduced into the Court of the Exchequer, and the accounts were kept, much as Robinson Cruso kept his calendar on the desert island. In the course of a considerable revolution of time, the celebrated Cocker was born, and died: Walkinghame, of the Tutor's Assistant, and well versed in figures, was also born, and died; a multitude of accountants, bookkeepers, and actuaries, were born, and died. Still official routine inclined to these notched sticks, as if they were pillars of the constitution, and still the Exchequer accounts continued to be kept on certain splints of elm wood called "tallies." In the reign of George III an inquiry was made by some revolutionary spirit, whether, when pens, ink, paper, slates and pencils, being or existing, this obstinate adherence to an obsolete custom ought to be continued, and whether a change ought not to be effected.

All the red tape in the country grew redder at the bare mention of this bold and original conception, and it took till 1826 to get these sticks abolished. In 1834 it was found that there was a considerable accumulation of them; and the question then arose, what was to be done with such wornout, worm-eaten, rotten old bits of wood? I

[3]*A Short History of Mathematics*, p. 26.
[4]*Prologue to Canterbury Tales*, l. 569-572.
[5]Shakespere, 2 Henry VI, IV, viii, 38.

dare say there was a vast amount of minuting, memoranduming and despatch-boxing, on this mighty subject. The sticks were housed at Westminster, and it would naturally occur to any intelligent person that nothing could be easier than to allow them to be carried away for firewood by the miserable people who live in the neighborhood. However, they never had been useful, and official routine required that they never should be, and so the order went forth that they were to be privately and confidentially burnt. It came to pass that they were burnt in the House of Lords. The stove, overgorged with these preposterous sticks, set fire to the panelling; the panelling set fire to the House of Lords; the House of Lords set fire to the House of Commons; the two houses were reduced to ashes; architects were called in to build others; we are now in the second million of the cost thereof; the national pig is not nearly over the stile yet; and the little old woman, Britannia, has not got home tonight.[6]

Important and useful as these three methods of computation may have been during the middle ages, *the* instrument for any sort of arithmetical calculation was the abacus. Knott says:

It possesses high respectability arising from its great age, its widespread distribution and its peculiar influence in the evolution of our modern system of arithmetic. Our children soon pass to the modern cipher system of notation. But in India, China and Japan it still holds its own as a scientific instrument.[7]

There are three general types of abaci; the dust table, the table with loose counters and the table with fixed counters. The dust table was a board or table over which fine dust was scattered. The computation and figures were then drawn on it by means of a sharply pointed stylus. Another variation of this form was the wax tablet and slate. The counter abacus was a table upon which lines were drawn. Loose counters or disks were placed on the lines and received their significance from the place of the line. In some of the later models, counters were marked with a certain number and hence only one counter was placed on a line. The third type was a wooden or metal frame on which were strung beads or pebbles. A variant of this is the Roman abacus with grooves along which the counter could freely move.

The origin of the abacus is very obscure. It is probable that it was first used in Asia Minor from whence it spread eastword to China and westward to Europe. Radolphus of Laon expressly states that it is of eastern origin and connects its name with the Semetic word "Abq," dust.[8] Herodotus declares that the Egyptians employed it as early

[6]"Administrative Reform," *Speeches*, p. 437.
[7]"The Abacus," *Transactions of the Asiatic Society of Japan*, XIV, p. 19.
[8]Sir Clive Bayley, "The Genealogy of Modern Numerals," *The Journal of the Royal Asiatic Society of Great Britain and Ireland*, XV New Series, p. 9.

as 461 B. C., saying "they write their characters and reckon with pebbles bringing the hand from right to left, while the Greeks go from left to right." We have no written record of the Egyptian abacus, nor any specimens extant, nor even any drawings or wall-pictures. We have, nevertheless, many coins or counters which may have been used for this purpose. We know for certain that the Egyptians usually multiplied by doubling and divided by mediating, processes especially adapted to abacus computation. The Hindus very early used a wooden tablet covered with pipe clay over which was sprinkled purple sand.

It was popularly supposed among the Greeks that Pythagoras introduced the abacus into that country. Iamblicus states that it was on this instrument that Pythagoras taught arithmetic and geometry. This would lead us to believe that the dust table was familiar to them. They also used the counting board, a comparatively perfect specimen of which was discovered on the island of Salamis.[9] It is of white marble 1.49 x .79 meters, ruled with two groups of lines. One group of eleven lines was used for counting money, the symbols of which are carved on the side of the marble slab. The smaller group of six lines was used for computing fractional values of the drachma. There are many references to the abacus in Greek literature. Diogenes Laertius says, "A person friendly with tyrants is like the stone in computation which signifies now much, now little." Polybius has a similar passage describing courtiers as exalted or depressed in condition at the will of the king, just as the counters on the abcus are made to signify talents or oboli at the will of the person using them.

The Romans used all three forms of the abacus. It was even more useful to them than to the Greeks. The system of notation in Greece lent itself more or less to manipulation, but imagine the difficulty of multiplying MCCCCCXXXXVIIIJ by SXXC![10] The grooved abacus seems to have been a Roman invention and is known to us only from a few specimens of uncertain date which have come down to us. References to the abacus are frequent

[9]David Eugene Smith, *History of Mathematics*, II, p. 162.
[10]David Eugene Smith, *History of Mathematics*, II, p. 59.

in Roman literature. Horace describes the school-boy with his abacus and box of pebbles suspended from his left arm. Juvenal speaks of counters of ivory, silver, and gold, while Cicero refers to "the brass pieces."

The Chinese abacus is of comparatively recent development, being an innovation of the 12th century. Many writers place its introduction much earlier but we find the first definite description of it in 1174 when it is referred to as "the Tray" in "Pan chu tsik." Not until 1593 do we find Ch'eng Tai-wei describing the suanpan computation.[11] The suan-pan or "computing plate" is similar to the Roman abacus in construction. It consists of balls of bone or ivory strung on a wooden frame. The Chinese are very proficient in the use of this instrument being able to obtain the desired result more swiftly with it than a "Lightning Calculator" can obtain the same result using western methods.

The Japanese have derived their instrument from the Chinese but have become much more expert in its use. The name "soroban" is a mispronunciation of the Chinese "suan-pan." It was introduced into Japan by Hideyoski,[12] more familiarly known as Taiko, who, having subdued the country by conquest, wished to cultivate the arts of peace. To that end he sent Mōri, a Japanese scholar, to China to obtain whatever information he could. Mōri being of low birth, was not well received by the Chinese scholars. He brought back to Japan, nevertheless, some information of which the abacus or suan-pan is supposed to have been the most important. The Japanese have developed it to a high degree of perfection, performing with its help not only the four fundamental operations but raising numbers to the second and third powers, extracting the corresponding roots, and solving equations. Knott speaks of the singular beauty and compactness of the arithmetical operations on the soroban.

All three forms of the abacus and their variations were widely used in western Europe during the middle ages. In fact so prevalent was this form of computing that it came to be identified in the mediaeval mind with the science of arithmetic. The Treviso arithmetic,[13] the first printed text

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[11]Ibid., p. 169.
[12]Kenneth Scott Latourette, *The Development of Japan*, p. 320.
[13]*The Source Book of Mathematics*, p. 1.

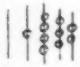
on that subject opens thus: "Here beginneth a Practica, very helpful to all who have to do with that commercial art commonly known as the abacus." The instrument was considered as fundamental in the art of computation as pen and paper. Robert Recorde says: "Arithmetic is a Science or Art teaching the manner and use of Numbering. This Art may be wrought diversely, with Pen or with Counters."[14] Teachers of arithmetic were frequently called abacists.

As early as the ninth century we have a reference to the dust table. Remigius of Auxerre speaks of the board sprinkled with blue and green sand on which figures were drawn with a "radius." A common variation of this type is the wax tablet. This was a slab or block of wood over which a thin coat of black wax had been smeared. The figures were written with an iron stylus, one end of which was pointed for writing, the other spoon-shaped for erasing by smoothing the wax down again. It was very popular in commercial houses and schools until replaced by the slate or blackboard in the latter part of the 15th century.

The Roman grooved or string abacus although it was used to a certain extent does not seem to have been very popular. It was much more cumbersome than the other two forms, a fact which may account for its unpopularity. This form, however, was improved by a plan erroneously attributed to Boethius. Counters bearing numbers were attached to movable rods or cylinders which could be moved so as to indicate desired results. This provided movable scales that could form number combinations without actually performing the calculation. The most famous example of these rods were Napier's "bones," the direct predecessor of our modern adding machines.

The line abacus was the most popular of all the types. It was called the counting table or counter and the disks used in calculation were counters. The lines represented denominations, the first one units, the second tens, and so on, and the counters received their value from the line upon which they were placed. It was customary to use as many counters as the number to be indicated. For instance in writing 1432 the abacist would place his counters in the

[14] "*The Ground of Arts*," *The Source Book of Mathematics*, p. 13.

manner:  Gerbert introduced the marked counters, at a later date, that is on his abacus 1432 should be indicated thus  . These counters, however were never very satisfactory. The advantage of using marked counters was apparent rather than real since the time and trouble saved by having fewer counters did not compensate for difficulty and waste of time involved in choosing the proper piece. In the latter part of this period the space between the lines were also invested with significance, and finally, the lines were eliminated altogether. In "The Ground of Arts," 1543, Robert Recorde says: "This sort of reckoning is in two fourmes commenly. The one by lynes, and the other without lynes."[15] His diagrams, however, all follow the system with lines. In discussing the use of the spaces he says:

> . . . you haue not one figure for 2, 4, 3, nor 4 and so forth, but as many digettes an you haue, you set in the lowest lyne: and for euery 10 you set one in the second line: and so of other. But I know not by what reason you set that one counter for 5 between two lynes. M. you shall remember this, that when so euer you made to set downe 5, 50, or 500, or 5000, or so forth any other nomber, whose numerator is 5, you shall set one counter for it, in the next space aboue the lyne that it hath his denomination of, as in this example of 500, bycause the denominator is hundred, I knowe that his place is the voyde space next aboue hundredes, that is to say aboue the thyrd lyne.[16]

The abacus played a most important part in the development of our system of notation. Zero (in Arabic, "sifr") means emptiness, and the zero symbol "0" was first used to mean the blank column of the abacus. Since any involved or complex calculations were impossible until the idea of the cipher was originated, the abacus was almost an absolute necessity in arithmetic. Once the symbol came into use, however, any operation could be easily carried on with the Hindu or Arabic numerals. Hence the decay of the abacus in Europe can be traced to the introduction and perfection of the cipher system which in part, at least, owes its early origin to the abacus itself. Similarly in the East where the notation in use is still rather clumsy, the instrument holds undisputed sway.

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[15]F. P. Barnard, *The Casting Counter and the Counting Board*, p. 256.
[16]F. P. Barnard, *The Casting Counter and The Counting Board*, p. 256.

It has left many traces in the language of those who used it. The Romans used "calculi" (pebbles) on the line abacus, whence they have the verb "calculare" and we "to calculate." During the middle ages the counters were thrown on the board and we have the expressions "to cast an account" and the French "jeton." When the abacus was superseded by newer methods, those retaining the old method, and subsequently anyone of extremely conservative ideas was called contemptuously, "a counter-caster." The Germans called their counters "Rechenpfennige" or "Calculating pennies." The boards themselves they called "Rechenbanck" or simply "banck." From this we derive our "bank," "banker," and "bankrupt." The last term means literally, "a broken bank," the counters of dishonest or impoverished merchants being actually broken. The official bankers sat about a checker-board abacus called the exchequer, whence the English derive their "Court of the Exchequer," and the French their "Chambre de l' èchiquier."[17]

The counters used on these boards are very interesting in themselves. They were of gold, silver, lead, or bone, and were frequently embossed, in the latter part of the middle ages especially, with some heraldic design or motto. Princes and rulers had their own counters or jetons minted and these were often used as small change, being recognized as a species of small coins.

We no longer count on our fingers, or with knots in a string, and only the babies in our kindergartens use the abacus. Yet over these old methods of computation lies the indefinable charm of so many things mediaeval. They are so simple yet so ingenuous, so useful. They have proved an ever-constant source of interest not only to the student of the middle ages, but to the amateur mathematician to whom they reveal so much of the early historical background of the science of arithmetic and the art of calculation.

Bibliography

Books

1. Barnard Francis Pierrepont, M.A., F.S.A. *The Casting Counter and the Counting Board.* Oxford: The Clarendon Press, 1916.

[17]David Eugene Smith, *The History of Mathematics*, p. 188.

2. BEDE, VENERABLE. "De Ratione Temporum." *The Miscellaneous Works of Venerable Bede,* VI. Edited by the Reverend J. A. Giles, D.C.L. London: Whittaker and Company, 1843.
3. DANTZIG, TOBIAS. *Number.* New York: The Macmillan Company, 1930.
4. DICKENS, CHARLES. "Administrative Reform." *Speeches.* London: John Camden Hotten, 1869.
5. HEATH, SIR THOMAS, K. C. B., F.R.S. *A History of Greek Mathematics.* Oxford: The Clarendon Press, 1921.
6. HORDBURGH, E. M., M.A., B.Sc. *Modern Instruments and Methods of Calculation.* London: G. Bell and Sons, Ltd., 1917.
7. KARPINSKI, LOUIS CHARLES. *The History of Arithmetic.* New York: Rand McNally and Company, 1925.
8. LOYOURETTE, KENNETH SCOTT. *The Development of Japan* New York: The Macmillan Company, 1926.
9. MANSOLINI (Possible author). *The Treviso Arithmetic.* Treviso, C.1478. A Source Book of Mathematics compiled by David Eugene Smith. New York: McGraw-Hill Book Company, Inc., 1929.
10. RECORDE, ROBERT. *Accomptynge by Counters.* The Earliest Arithmetics in English Edited by Robert Steele. London: Oxford University Press, 1922.
11. *The Declaration of the Profit of Arithmeticke.* A Source Book in Mathematics compiled by David Eugene Smith. New York: McGraw-Hill Book Company, Inc., 1929.
12. SANBORN, VERA. *A Short History of Mathematics.* New York: Houghton, Mifflin and Company, 1930.
13. SMITH, DAVID EUGENE, Ph.D. *A Source Book in Mathematics.* New York: McGraw-Hill Book Company, Inc., 1929.
14. *A History of Mathematics.* New York: Ginn and Company, 1925.
15. YELDHAM, FLORENCE A., B.Sc. *The Story of Reckoning in the Middle Ages.* London: George G. Herrop and Company, Ltd., 1926.

Periodicals

16. BAYLEY, SIR CLIVE, K.C.S.I., C.I.E. "The Genealogy of Modern Numerals," Part II. *Journal of the Royal Asiatic Society of Great Britain and Ireland:* New Series, 15:1-65, 1883.
17. KNOTT, C. "The Abacus." *Transactions of the Asiatic Society of Japan:* 14:18-52.
18. LOCKE, LESLIE LELAND. "The Ancient Quipu." *American Anthropologist:* 14:325-345, 1912.

PRECIOUS ALLOYS SHOULD FIND WIDER APPLICATIONS.

Alloys of precious metals should prove useful in other fields than dentistry, the American Society for Steel Treating was told by Prof. R. C. Brumfield, of Cooper Union, New York City.

Gold, silver, platinum, palladium, and other rare elements, when alloyed with the baser metals have service qualities that can be known only by actual experimentation, according to Prof. Brumfield. It is estimated that eight million combinations are possible, each with its unique characteristics. Only a few of them have ever been developed, and these have been used in dentistry. The resistance of these alloys to discoloration and their possibilities for heat treatment, recommend their use elsewhere, Prof. Brumfield said. The ultimate strength of some of these metals is as much as 90 tons per square inch. The strength of steel ranges from 50 to 100 tons per square inch.—*Science Service.*

HIGH SCHOOL BIOLOGY AS A CONTRIBUTING FACTOR IN HEALTH EDUCATION.

By Mary Elizabeth Lynch,

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Although there has been a vast change in the aims and methods of teaching biology during recent years, many high school teachers are still devoting time and energy to attempting to pass on to their pupils a diluted type of college course. As a result, little that is educationally valuable can be derived from the course and biology falls into disrepute as a subject unsuited to the student of high school age.

It has been found that to stress classification and morphology instead of biological principles, functions and activities is productive of no good results. The high school student is well able to grasp the great underlying factors such as the similarity of all living things, but he lacks background for the more detached study of morphology and classification. The stressing of this basic similarity has been almost entirely neglected until recently. Since its importance has been realized, attention is being directed toward the study of life histories and habits with increasingly good results.

Laboratory materials have changed as much as have methods and technique. In former years, dried specimens of both plants and animals were used almost exclusively, while the student without an herbarium could not claim to have really studied biology. A great deal of time was spent in the minute dissection of preserved specimens, and microscopic work far beyond the natural abilities of the pupils was prescribed. All of this has been radically changed in recent years. Material for laboratory work is now selected on the basis of the interest of the pupil and its educational value. By such a viewpoint, the practice of dissection is absolutely abandoned when its only aim is to show evolution through morphology and its use is greatly minimized at all other times.

Wherever possible, living specimens are used and their fundamental processes studied. Although the individual laboratory method is valuable for giving the pupils first-hand, practical experience with organisms, it is not used exclusively at the present time because the lecture-demon-

stration method has proven itself far superior for fact getting. It is manifest that a single, well performed experiment by the teacher may produce more and better knowledge than when poorly done by each pupil.

The tendency to use physiological and ecological materials instead of purely morphological ones is growing. The pupils show the greatest interest in things from their own environment and thus civic biology is finding an important place in the biology course.

Underlying and motivating all of these changes in the method and content of the high school biology course are the changes in aim which characterize all secondary education. These aims are crystallized as the Seven Cardinal Principles of Secondary Education which were compiled by the committee on the reorganization of secondary education, appointed by the National Education Association. The study of biology offers a unique field for the development of these aims. With the possible exception of the second —the command of fundamental processes—each one of the principles is closely bound up with the study of biology. For the present purposes, the connection with health is to be most closely observed. It is safe to say that without health all of the other ends of education are either wholly or in part prevented from functioning properly. It is very necessary during the years of adolescence to give the pupil a firm scientific background for the habits and health knowledge which he has gained in the elementary school. The biology course provides unlimited material and opportunity for making health education its chief aim, both general and particular. In fact, it may be said that the justification of the high school biology course is, in large measure, its great contribution to the health knowledge of the pupil. Although training in the command of the fundamental processes is not directly the work of the biology teacher, she must constantly be attentive to the demands for a high standard of English in her classes. To stretch the point a little, one might class health habits among these fundamental processes. Under such classification, the biology course is a most valuable aid to the furtherance of the aim. Here close watch may be kept on the survival of previously formed habits and new or neglected ones may

be inculcated. However, a direct contribution is made by biology to worthy home membership. Not only does it broaden the culture and interests of the student, but it also gives him a basis in scientific knowledge for forming a correct attitude in the family toward the care and control of communicable diseases, as well as personal and community hygiene and sanitation. The old, much adhered to superstitions concerning both health and disease are replaced by reasonable facts and practical knowledge. Although this training might have little or no effect upon the present generation of parents, nevertheless, it would be preparing an enlightened parenthood for the future. Moreover, it has numerous times been demonstrated that the ideals and customs which children acquire in school influence many parents to a great extent. This is especially true in the families of foreigners who look to their children for information about American ways of living. Biology teaching, particularly in its relation with health education, gives the child a real apostolate in his home and in the community at large. In another phase of the study, the pupil is interested in plant life and very often is lead to cultivate a garden at home. He is shown the wonders which may be accomplished by allowing a bulb to sprout and he is given some idea of vegetable planting and cultivation. Hence, it is possible for him to start a "garden" anywhere from the crowded tenements to the spacious suburbs. There are few things which add so much to the home atmosphere as does a growing plant. There is something about it which radiates the sense of security and peace which is the keynote to home. In all circumstances, the pupil has an opportunity to add to the beauty of the home surroundings and to the happiness of its members. Therefore, one of the chief aims of the biology teacher is to prepare the pupil for more worthy home membership.

In the great majority of cases, the vocation aim of biology teaching is indirect, but nevertheless, it is important. Regardless of calling, good health and the knowledge of how to retain it is indispensable for success. Biology gives valuable and direct training to those people whose life work is to be in farming or allied occupations. It teaches those who turn to the factories and shops of conditions which

are necessary for safe living and warns them of the dangerous occupations. Those who enter higher institutions are prepared for more advanced scientific work and are provided with a basis in the knowledge of life functions.

Citizenship involves the social conduct of the individual and requires that he contribute his best to the interests of the community. Civic biology teaches the responsibility of the individual to the community and that of the community to the individual. It illustrates graphically the far reaching and disastrous effects of anti-social conduct as exemplified by carelessness in matters of disease. The pupil has a chance to see what the community is doing for his welfare and learns how best to co-operate with these efforts. The desirability of co-operation itself is clearly shown by the study of the interdependence of living things. Here the student may learn the ideal of true social conduct and by careful guidance be lead to contribute his best efforts toward it.

When high school biology is properly taught, it should foster a genuine love of nature and the outdoors, and should call the pupil to spend much of his leisure time in the fresh air. To a person who is ignorant of the wonders of the natural world, a walk in the country may seem hopelessly dull and boring. Give that same person a little insight into the life about him and the walk will take on a real significance. Frequent field trips and individual investigations and problems given with the high school biology course will show the pupil how to spend profitable and enjoyable leisure hours in the years to come. In some cases the study may develop into a hobby or avocation which will occupy leisure time in the future. This may be in any form from the observation of wild life to the cultivation of a kitchen garden, but in all cases it will be a worthy use of leisure and serve as true recreation to the mind and body.

The biology course is very useful in pointing out to the pupil his duty to the community in that the harmful results of a lapse from that sense of responsibility are readily seen. Much can be done to foster ethical character during high school days because of the idealistic trend of the adolescent mind. The biology teacher should aim to develop a spirit of service to others in his pupils.

In addition to these general aims of all education, the biology teacher has certain specific aims peculiar to her individual work. Many of the pupils, especially in the city, come to her without even a rudimentary knowledge of nature and with no special interest in it. It is necessary, therefore, to arouse an interest in the immediate environment and so foster it that the pupil may carry the interest with him throughout life. Upon this basis of interest may be built the superstructure of detailed biological knowledge. The stimulation of worthwhile thought is very important in the mental development of the student. Therefore, the teacher must provide suitable material for such activity as well as material which will establish desirable mental attitudes. The latter are of signal importance since they should be the enduring effects of scientific study in the high school. The content of science is always changing, but the scientific attitude remains fixed. It is a great mistake to drill the pupil in specific knowledge to the exclusion of such qualities as open-mindedness, tentative theorization, and underlying methods of scientific investigation. The teacher should aim to impress the value of these qualities and show the pupil the need for willingness to hear all sides of a question before forming an opinion. It is essential, also, that he should be willing to change his ideas on a subject when new knowledge demands. Progress is always impeded by people who lack the ability to substitute new theories for old. In order to guard against too liberal or too changeable an attitude, the teacher must also train the pupil to question the evidence carefully and build up an idea by logical procedure. This is a particularly good time for training in logical thought methods, since the mind of the pupil is interested in that phase of thought.

Throughout the study of biology, the teacher aims to show the relation of form and structure to function and to let the pupil see the ways in which living matter adjusts itself to the exigencies of environment. At the same time he is given an idea of the continuity of life which leads to a consideration of the theory of evolution. It is most necessary that the teacher give both pros and cons impartially and lead the student to think for himself in accepting or rejecting this important theory. In fact, the development

of the individual point of view is of great value.

All of the foregoing specific aims are invaluable in providing a background for health work, but the biology teacher should aim at direct contribution to health knowledge. Wherever there is a diversity of material from which to choose, that which stresses human welfare in relation to health should be selected. Often a word will lead to a better understanding of the needs of human beings by relating the knowledge of the requirements of plants and animals with those of man. During the study of parasitic organisms, the student should be led to a cleaner personal and civic life through the stressing of sanitary habits and ideals. The relation of man to other organisms, both economically and biologically, is a point which cannot be disregarded. The biology course should acquaint the pupil with the results of scientific inquiry and their application to hygienic methods. This leads naturally to a study of the work of Health Boards and other similar organizations which have as their aims the spread of valid scientific knowledge. The biology teacher should strive at all times to present the subject matter in such a way that the pupils will develop a wholesome and natural attitude toward sex. One aid to this is the study of life processes in plants and animals. Of equal value is the suggestion for healthful diversion in the fresh air to which nature study should lead.

It is important that the pupil himself should be conscious of very definite aims in his study of biology. Many of these aims may be formulated by the pupil at the beginning of the course and others may be suggested by the teacher. The class should make a list of the aims and keep it in a prominent part of the biology notebook where it may be referred to frequently. Mandle, in his Biology Review, gives twelve comprehensive reasons for the study of biology. These stress the health value very well, so they are given below.

The study of biology teaches us:

1. To understand the structures of our own bodies.
2. Methods of preventing disease and loss of life.
3. How to improve the health and beauty of the community.
4. Ways of securing better living conditions.
5. How to find how to distinguish harmful from beneficial plants and animals.
6. How to improve plants and animals.
7. How to destroy harmful plants and animals.

8. The proper way of utilizing living things for our benefit.
9. Proper methods of farming and gardening.
10. Why and how we should conserve our natural resources such as: Forests, vanishing wild life, food and domesticated animals.

In addition, biology

11. Helps us to develop our reasoning power.
12. Has cultural value. Life means more to a person who has a knowledge of biology.

With such a guide, the pupil is helped to see the real and vital meaning of the work in the course and is not led along blindly through a maze of disjointed facts. He can see the practical value of biological knowledge in relation to his health as well as to his general education and interests.

For many years, biology has been taught in the high school, but without particular reference to its relation to health education. In fact, health education is a new departure in itself, featuring, as it does, correct habits of living rather than detailed knowledge of the rather fruitless facts of anatomy and physiology. Fruitless, that is, in themselves, but most essential in part as a foundation for the health studies. However, only such knowledge of anatomy and physiology which has a direct health value should be given. Obviously, many time consuming exercises such as learning the name and position of every bone in the body, may be omitted. In the place of such knowledge, that which will help to improve the physical and mental health of the pupil is stressed. First of all, the health educator aims to give the high school pupil an understanding of the scientific basis for health. It is important that he should know the facts about the more common diseases. This knowledge should include the infectious agent, the source, the site, the infectious discharge, the symptoms produced, and the effects of the disease upon the body as well as the method of control. In this relation, also, the pupil should be taught what he as an individual and the community at large can do in the checking of disease. By no means should this study of diseases be over-emphasized, but it cannot be disregarded. Greatest stress should be given to facts relating to the preservation of health, such as cleanliness, sanitation, food, fresh air, exercise, and rest. The lives and contributions of the great scientists who have done so much for the promotion of health, as well as a study of current events in the battle for health should be

of much value. The pupils should know what the leading investigators are now seeking and should be taught to have an intelligent interest in the news of their activities.

All of this knowledge is of doubtful value unless it is applied in healthful living standards. Many different sets of habits must be set-up each important in its own sphere. There are personal habits to be formed and maintained to preserve or improve the health of the individual. Another set of essential habits relating to school life must be observed, while still a third set are necessary for correct living in the home. In addition, suitable habits must be formed to aid the pupil in rising to the various emergencies with which he may meet at one time or another.

These practical habits and definite knowledge must be accompanied by the formation of ideals and high standards of health which will not only inspire the students to improve their own health, but also will improve the life of future generations. The best possible time for developing and inculcating such ideals is in the high school period when the pupils are beginning to form their attitude toward life in general and are much more easily influenced by a high ideal than at other times.

Although the physical health of the school boy or girl is of utmost importance, there must be a conscious and purposive effort made to improve and strengthen the mental health for it has much to do with the proper functioning of the individual, however perfect he may be physically. In the health education course, the work for mental health is both subjective and objective. The pupil should be taught to employ correct and economical methods of study and should be aided in every way to develop his powers of concentration to the utmost. He should be given every opportunity to acquire the feeling and habit of success through his own efforts. He should be led to know himself and to have confidence in his own power, so that he may act with independence and self-reliance. It is important, also, that the pupil be trained to meet the situations of life squarely and aggressively. For this, many qualities are necessary. First of all is the need for a strong will power. This may be acquired by conscious exercise and the health course offers many opportunities for such exercise. For example,

restraint in the choice of foods, going to bed early, and countless others. To meet a situation well, the pupil needs resourcefulness which may be stimulated and trained by the solution of health problems bearing on every-day life. It is also most necessary that he be persistent in remaining steadfast until he has done away with the situation. This quality is often weak in high school pupils and all possible encouragement must be given for its development. Another problem of this age is the tendency to postpone making a decisive choice between things or events. For the mental health of the pupil it is necessary that he be trained to overcome this weakness by much opportunity for the exercise of choice.

It is the part of education for mental health to develop a diversity of attitudes and interests, both social and intellectual, which will broaden the life of the pupil. He must be led to have a companionable attitude toward his fellow pupils and to feel a real sense of responsibility toward the community at large. For the establishment of these attitudes, he must be helped to acquire the qualities of unselfishness, truth, honesty, and helpfulness. Intellectually, his interests must be broadened to give material for developing worthwhile avocations which will stimulate strong mental activity.

Although the movement for the health education of the individual is manifestly of the greatest importance, it has as yet hardly reached the high school. Beginning in the kindergarten, it has made its way upward through the grades meeting with great success. Since very little of the old type physiology had been taught in the lower grades, a clear field was provided for the evolution of the best methods with the advent of the new development. The experimentation in methods has been very progressive. As a result, it has been found that a control of passive environment is of much less importance than was previously supposed. The well known statistics of physical examinations during the war proved this beyond doubt. Therefore, the importance of active education for health is being advocated more and more in recent years. In fact, the tendency to swing too far in that direction to the neglect of the passive environment must be carefully guarded against because neither phase is wholly satisfactory without the co-opera-

tion of the other. As for the direct teaching, only that which shows the pupil why he must live hygienically in order to live happily and usefully is necessary. To this end, practical health habits are emphasized and physiology study minimized. In answer to the new demands, the more recent texts are omitting unnecessary details and are making their contents better suited to the interests and needs of young pupils.

Because of the long time which the health education movement has taken in reaching the secondary schools, pupils already trained in elementary health education are entering the high schools. This greatly facilitates the advance of the movement and allows for satisfying needs peculiar to the high school pupil. Hitherto, the student has been trained in habit formation with the minimum of scientific knowledge of reasons for the formation of the habits. The biology course is most useful in providing a satisfactory scientific background by means of which the habits may be supported. What is more, the proper training in health education is of the greatest importance in molding the public opinion of the future on such matters. Pupils who know the need for sanitary living conditions and hygienic habits will make the more efficient parents of the next generation. Not only will their own health be benefited, but also their children will be better trained in healthful conduct from infancy. Of equally high importance is the effect which a more intelligent understanding of health matters will have upon the press. It is a well known fact that newspaper reports on health subjects are frequently most inaccurate, often misleading to the point of harmfulness. Another important need for health education in the secondary schools is to establish a better understanding and co-operation in health matters between the public at large and the various health departments of the city and state. Ignorance has often lead not only to a lack of co-operation, but even to an antagonistic attitude and efforts to thwart measures for the check of disease. The high school can do much to ameliorate this condition.

It is plain, therefore, that, although the general methods of the elementary school are efficacious in the high school, the basis for teaching changes to meet the demands of older pupils and different subject matter. In the lower grades

the teaching is authoritative, stressing personal health habits. When the pupil reaches the intermediate school, social motivation is used and importance is given to the study of the welfare of the community at large. The high school should disregard neither of these factors, but the major foundation must be scientific knowledge which will explain the other two. Health, as a motive in itself, has been proven to be useless in the grades and it is no more effective in the high school. An immediate reward is necessary to insure strong motivation and the rather illusive reward of health is in no way sufficient. It is necessary that all teaching be based carefully upon psychological procedure. The course should be broad enough to increase and develop physical well-being, provide a sound health knowledge, and wholesome health ideals, and should be narrow enough to make each fact taught function in the life of the pupil.

The high school biology course can be very closely allied to the work in health education, because a large part of the subject matter is identical. Nevertheless, it should not be expected to substitute entirely for an individual course in health education or to make a far-fetched correlation between the two subjects. To make the biology course function in health education, no change of subject matter is necessary, but rather a change in perspective which is by no means difficult, since the new trend in biology emphasizes principles, functions and activities rather than classification and morphology. It is essential to a scientific education that the pupil be given a firm foundation in understanding the principles of life. To that end, the biology course teaches him the nature of protoplasm, its chemical, physical, and physiological properties, as well as important facts about the cell structure of living things. This leads to a study of the fundamental processes as found in both plants and animals with special relation to human conditions and health. Under nutrition it is well to teach the importance of plants in providing food for animals. While studying food making and storing, the pupil may be taught the function of food and its composition. Carbohydrates, proteins, oils, minerals, vitamines, and roughage should be given careful treatment both as to value and sources. This will lead to the process of food taking where the relation

of food to health is to be studied. Much valuable health work may be done under that topic. The various deficiency diseases and the nutritive value of different classes of food should be considered. While these studies are progressing, the pupils may start several health activities such as correlating height and weight with a diet record which should show the proportions of each food type used, or they might build better food habits. There is also the opportunity for the development of self-control in the selection of food.

When the pupils have studied food making and taking they are ready to follow through the processes of nutrition such as digestion, absorption, circulation and assimilation. Constipation should be given very special attention from a hygienic viewpoint with emphasis upon the necessity for regular habits and the relation of food and water to elimination. At the same time the care of the skin and hair may be taken profitably and a campaign for good health habits in that direction may be launched.

In studying respiration, the effects upon general health are to be considered and enthusiasm for outdoor life should be fostered. The study of the nervous systems of various types, especially of the frog, offers opportunity for teaching the nature of sensation. The physiology of habit formation may be illustrated and learned through the building of a new or discarded health habit. At the same time, the principles of mental health may be taught. Some of the class might keep graph records of an attempt to establish some quality such as self-control or persistence while the others are working on the health habit.

The study of motion may be correlated with the consideration of exercise and fatigue. The pupils might make a study of their own conditions, both in work and play. Although the power of growth and repair will have been met in the first study of protoplasm and later related to nutrition, it is important enough to require individual treatment. In correlation with it, a special study of Height-Weight charts should be made and efforts made to correct any defects which these may disclose.

In tracing the process of reproduction in plants and animals, there is an excellent chance for producing a wholesome attitude toward sex. This may be done very simply through the use of plant material. Although human con-

ditions are not identical with those of lower organisms, the principles of selection and breeding, as well as the effects of heredity and environment which may be developed at this point are helpful.

In addition to the correlation with health education of the fundamental life processes studied in the biology course, there are many points of correlation with the interrelations of plants and animals. From an economic viewpoint the use of plants by man may be considered. The study of those which give food, clothing and shelter, medicines and commercial products all help to make more clear the dependence of man upon the vegetable world. In this consideration, bacteria cannot be overemphasized but they may be studied more fully later. The selection of saprophytes and parasites for study should be based on their relation to man's health and comfort. In making a choice the needs of the section of the country rather than the general interest should be considered.

The relations of insects to plants and other animals also give a basis for health studies. If the carbon and nitrogen cycles have not been covered by the work on nutrition, they may well be taken at this time.

Doubtless, the most important and practical correlation of biology and health education lies in the study of the life histories of various organisms in their relation to man's health. The malarial parasite not only serves as an excellent example of the life history of a parasitic protozoan, but also contributes valuable health information. Additional examples may be found in yellow fever and sleeping sickness. The heroic struggles for control of yellow fever by Reed, Carroll, and Lazear provide great inspiration.

In the study of bacteria, yeasts, and molds, many excellent and graphic experiments may be performed. In every case they should be fully recorded with special attention to the practical application of the conclusions reached. Some of the more important ones are listed below.

Effects of cold on bacteria: Place bacteria on culture medium in two Petri dishes. Place one dish on ice, the other in a warm place. Observe results in three days.

Effect of heat on bacteria: Place bacteria on culture medium in two Petri dishes. Allow one dish to remain in an ordinary temperature. Expose the other to a very high temperature for at least one hour. Place both dishes in a warm place for several days. Observe results.

Effect of dryness on bacteria: Place a dry piece of meat on a blotter in a glass dish and a wet piece of meat on a water-soaked blotter in a glass dish. Allow both dishes to remain in a warm place for a few days.

Effect of sunlight on bacteria: Place bacteria on cultural medium in two Petri dishes. Cover one dish with a light proof box. Expose the other to direct sunlight for a day. Then place both in a warm dark place for several days.

Effects of disinfectants on bacteria: Place bacteria on culture medium in several Petri dishes. In all but one, place various disinfectants. Let the dishes remain in a warm place for several days.

Bacteria in house dust: (1) Expose sterile culture medium in a Petri dish while dusting a room. (2) Expose sterile culture medium in a Petri dish while a room is swept. (3) Expose sterile culture medium in a Petri dish while a room is being brushed. (4) Expose sterile culture medium in a Petri dish while vacuum cleaning a room. Allow all of these dishes to remain in a warm place for several days, then compare results.

The housefly as a carrier of bacteria: Prepare two Petri dishes containing sterile medium. Allow a fly to walk over one surface. Place both dishes in a warm place for several days. Observe results.

Bacteria carried under fingernails: Place material from under fingernails on sterile medium in a Petri dish. Place the dish with a check in a warm place for several days.

Bacteria in the mouth: Place scrapings from unbrushed teeth in sterile medium in a Petri dish. Put this with a check dish in a warm place for several days.

Many similar experiments may be used to teach the characteristics of bacteria and from them numerous health conclusions may be drawn with desirable emphasis.

In studying the relation of bacteria to man, it is always well to pay special attention to the value of the beneficial bacteria in order to prevent the development of bacteriaphobia by some of the class. Then too, it is wise to stress methods of prevention and destruction of disease rather than the pathogenic activities of harmful bacteria. Only that which will help the pupil to better living should be included. Unnecessary details, especially those of an unpleasant nature must be eliminated for the good of the pupil.

When bacteria as a cause of food deterioration are considered, a project may be started by the pupils in applying the facts learned to the needs of their homes and stores. This leads, also, to the study of the methods of preserving foods and the relation of such methods to health.

As far as is possible, pathogenic bacteria should be considered from the preventive and destructive point of view as has been demonstrated. Although there are many different aspects from which the various diseases caused by bacteria may be considered, that of the avenues of entrance

to the body is best for present purposes. Septicaemia, boils, and tetanus which enter through abrasions in the skin lead to a consideration of first aid and the subsequent care of cuts. Those which enter through the nose and mouth offer much profitable material for study. Tuberculosis shows splendidly the results of proper treatment in care and prevention. The importance of correct diet and living habits should be emphasized. The study of the Schick and Dick tests for determining susceptibility to diphtheria and scarlet fever is not only of intellectual interest and value, but also very important in removing old superstitions concerning those diseases and their treatment. In considering typhoid fever, the pupil is lead to a general study of community sanitation which will be governed in its scope by the character of the environment.

A study of the principles of immunity and immunization is of signal importance and provides many interesting special pieces of work such as topics for report during the biological study of pathogenic bacteria. The experiments with disinfectants are sufficient to acquaint the pupils with exterior means of destroying bacteria.

Correlated with the study of green plants should be the study of poisonous plants. Previous to this, certain fungi will have been studied; so poison ivy, poison dogwood, poison sumach, poison primrose, and wild parsnip will comprise the important part of the material. Not only should the pupils be taught the character of poisoning caused by each, but also the general characteristics of the plants and their habitats. At the same time such details as the cause and treatment of hayfever may be studied, as well as certain personal idiosyncrasies such as tomato and strawberry poisoning.

Although the grasshopper is used as the type in the study of insects, the importance of smaller ones such as the fly cannot be disregarded. If the pupils have performed the experiments to determine whether the fly is a carrier of bacteria, they already have some idea of what a menace it is to health. If possible it is well to have the fly pass through its life history in the laboratory. From this may be deduced methods of control and destruction, and also knowledge may be gained of habits and breeding places. A class problem might consist of planning a campaign for ridding

the community of flies. The anopheles and stegomyia mosquitoes as disease carriers provide material for many special topics and class exercises. The class will find it interesting to chart all possible breeding places in the neighborhood and plan for their elimination. The flea, also, may be correlated with health work because of its relation to bubonic plague. The measures which the community takes for the control of that disease should be considered.

Throughout the biology course frequent study of the lives and work of distinguished biologists and others who have contributed to health should be made. Although the list is long, the more important ones are listed below.

Harvey—Discovered the circulation of the blood in the human body.
Lister—Father of antiseptic surgery.
Jenner—Originated vaccination for smallpox.
Metchnikoff—Found the function of the white blood corpuscles.
Koch—Postulates. Discovered tuberculosis germs.
Pasteur—Founder of serums, vaccines, antitoxins, etc.
Howard—Proved that the housefly is a carrier of typhoid fever.
Laveran—Discovered the malarial parasite in the mosquito.
Reed, Carroll, and Lazear—Discovered the means of transmission of the yellow fever parasite.
Flexner—Worked on antitoxin for germ diseases.
Stiles—Discovered hookworm in the United States.
Trudeau—Started modern methods in the treatment of tuberculosis.

Civic biology is always very interesting in itself to the pupils and is very important in acquainting them with the great agencies by which the community tries to protect itself from ill-health. Not only are the government organizations such as the City and State Boards of Health and the Federal agencies to be considered, but also such private ones as the American Child Health Association, the National Tuberculosis Association, and the Joint Committee on Health Problems in Education of the National Education and the American Medical Association. There are many colleges and research institutions to be considered, notably Bussey Institute, Smithsonian Institute, Carnegie Institute, Rockefeller Institute, Johns Hopkins, and many of the agricultural colleges of the West.

Thus far the correlations between biology and health education have been in direct teaching. The indirect contribution is also of importance especially in the province of mental health. The happy, purposeful atmosphere in the classroom should be such as to stimulate cheerful co-operation and concentrated effort. Many pupils come to the high school burdened with unreasonable dislikes, fears and su-

perstitions concerning living things. In exchanging for these the scientific truth, the pupil gains greater mental stability and lessens the chances for unbalance in later life. The nature of the work demands that the pupil proceed logically, solving one problem after another as carefully as possible. This helps him to gain the habit of facing situations directly and solving them at once. Although the carry-over may not be as effectual as might be wished, habits of neatness in the arrangement of experiments, care of materials, and disposal of refuse tend to impress the idea of order in all fields.

Since the biology course deals primarily with natural life, it develops an interest in the out-of-doors which might otherwise remain dormant. When the pupil knows something of the wild life which he meets, he is apt to spend his leisure time in recreation such as hiking and other outdoor sports. In addition to these considerations, are those benefits common to all subjects which may be gained by attention to posture, heat, light, and ventilation during the ordinary class procedure.

As a summary for the entire course, the biological principles learned might be directly applied to the human body with special attention to the sense organs and any other details which have not been previously covered.

Because of the great amount of material which must be covered in a one year biology course, special pupil participation in the work is very effective. Probably the chief form which this will take is that of oral themes. To make this work really worthwhile, the teacher should demand that every topic reported upon should be prepared by every member of the class, but elaborated upon by the speaker. At the end of each presentation, there should be opportunity for a general class discussion. In this way every member of the class should be held responsible for every topic. One or two of these topics might be given at every lesson or one day a week might be devoted entirely to them. This type of lesson is very valuable, since it acquaints the pupil with sources of knowledge outside of his textbook and also stimulates him to originate interesting methods of presentation. In addition to the purely biological subjects, there are many which afford excellent opportunity for correlating

biology with health education. The following list suggests a few of them.

The Benefits of Sunshine to Man.
The Importance of Outdoor Exercise.
What Is Droplet Infection?
The Structure of the Teeth.
The Hookworm and Health.
What the Schick Test Does.
The Life Cycle of a Tape Worm.
Vitamines.
Swat the Fly!
How One Gets Malaria.
How the Canal Zone Was Cleaned.
The Value of Vegetable Oils.
The Advantages of Having a Garden.
Typhoid Fever.
Insects in the House.
Useful Bacteria.
How to Prevent Colds.
The Nitrogen Cycle.
The Carbon Cycle.
The Balanced Aquarium.
What Vaccination Means to Civilization.
Do You Recognize Poison Ivy?
How We Can Aid the Board of Health.

The assignment of problems and investigations offers an excellent means for motivating review. Some of these problems might be solved in a single lesson, whereas others might extend over a considerable period of time. A few general examples are:

Plan a campaign to free the community of flies.

Chart all possible breeding places for mosquitoes around your own home.

Investigate sanitary conditions in a butcher shop.

When conducted properly field trips are of great value. It is most necessary, however, that each one be definitely worked out in advance and that the pupils know exactly the object of the trip. In all cases a written report should be submitted immediately after each expedition. The value of the trip to the pupil is both direct and indirect. Directly, he gains the facts which he went out to find. Indirectly he gains an interest and love of out doors which may help him then and later to a more wholesome use of leisure time. However, this depends largely upon the proper motivation of the work.

The high school pupil has reached the stage where his mental development is almost entirely associative and logical powers are developing. Because of this he greatly enjoys argumentation. This phase should not be neglected in planning the work for the biology course. An occasional

debate not only enlivens the class attitude, but also calls for earnest work on the part of the debaters. The following are representative of the type which may be used.

Resolved: That vaccination should be compulsory in the United States.
Resolved: That the city should provide more open air playgrounds.
Resolved: That all milk sources should be examined frequently.
Resolved: That vegetation around a house is beneficial to health.

Although so much of the biology work can be made identical to that of health education, it is a serious mistake to depend upon such correlation for all of the health education. In fact, it is a great injustice both to the pupil and to the biology teacher to expect it. Most states now require some health teaching in all high schools but the amount varies greatly. The general custom is to give a one year course which meets once a week. The disadvantages of such a plan are obvious. In the first place, the time is too limited for the inculcation of health habits to any useful degree. Then too, only a minimum of subject matter can be covered in that time. There is also a chance for many sections to lose three and even four lessons in succession because of vacations and holidays. Although a one year course meeting three or four times a week would be far superior to the present one hour course, the more effective plan would be a four year course meeting once a week. Accompanying this course should be a carefully planned correlation with all subjects, particularly biology. In this way the pupils would be given time to develop new attitudes and would be helped to see that health education is not an unimportant "freshman" subject, but a vital part of their daily lives. Pennsylvania has a four year course with a different objective for each year. In grade nine it is industrial hygiene, in grade ten it is home hygiene, while in eleven the school is the center of interest, and in grade twelve the subject of health and the community is considered.

The changing focus of biology teaching is being reflected in all of the better school texts which have appeared recently. The great majority of them are civic biologies, while others take such titles as Gruenbergs' "Biology and Human Life." Most of the biology text books are divided into sections dealing with botany, zoology and physiology separately, but the newer ones tend to make correlations

within the subject and are using practical material exclusively.

In order to obtain definite, worthwhile results in correlating any subjects, it is necessary that the course be carefully planned and the exact material which is to be correlated must be assigned to each department. This is especially true of health education. There is almost no high school course which cannot offer some points of contact, although the biology course is the one which gives the major correlation. Therefore, in the interests of efficient organization, some unitive force is necessary. The Cardinal Principles of Secondary Education suggest two solutions for the problem. One is to have a health director as a member of the principal's council. "This council member should seek to ascertain whether the health needs of the pupil are adequately met. For this purpose he should consider the ventilation and sanitation of the building, the provisions for lunch, the posture of pupils, the amount of home work required, the provisions for physical training, and the effects of athletics. He should find out whether the pupils are having excessive social activities outside of school, and devise means for gaining the co-operation of the parents in the proper regulation of work and recreation. He may well see whether the teaching of biology is properly focused upon hygiene and sanitation." *

The other plan seems more practical and conducive of better results. It is to have a committee of teachers, possibly one from each department, in charge of the active work for health education. The duty of this committee would be to work out correlative programs for each subject basing its work upon the needs of the community and the character of the courses being considered. One of its chief functions would be to keep the faculty in touch with the modern trend in health education. Other duties would be to co-operate with the doctor and nurse, to see that the school environment is healthful and to encourage healthful extra-curricular activities.

The latter plan divides the responsibility and work in such a way as to involve more people of varied interests and

*Cardinal Principles of Education. Page 28.

abilities thus making for a more general interest than would the first plan.

SUMMARY.

While distinct courses in which health is taught directly should not be omitted from the curriculum, the value of indirect teaching through correlation with the other subjects cannot be over estimated. If pupils are to be taught the real importance and desirability of health, they must see the need for it in all phases of their lives. Each high school subject can contribute something toward the broadening of the pupil's health vision which a direct health education course cannot do. Although the amount and worth of correlative matter varies with the subject, every possible chance for relating the work should be used. It is not necessary to talk health to the pupils until the word is a synonym for boredom, but through indirect methods a high health ideal may be inculcated.

The high school biology course teaches the underlying principles, functions and activities of living matter, and is, therefore, fundamental to a scientific knowledge of health. In fact, next to the direct health education course, it contributes more and better material for correlation than any other course in the curriculum. This makes it the greatest contributing factor toward health education in the high school. However, in order to use this correlative force to its highest efficiency, biology teachers must discard the old methods which do not provide a perspective in health education. In their place must be set up a new outlook which will motivate the establishment of health ideals, standards and habits.

Health education in the high school is so new that in many localities the initial steps have not yet been taken. Nevertheless, the need is evident and all progressive educators are preparing to meet it. Without doubt, the future shows great promise of far reaching progress in that field. To that end, it is the duty of biology teachers to prepare themselves in methods of health education as well as in the botany-zoology section of their subject. When this is done, they will be prepared to lead in the campaign of health education.

THE CONTENT OF A UNIT ON THE METALLURGY OF IRON AND STEEL FOR EIGHTH GRADE PROBLEM BOYS.

BY H. K. MOORE,

Thomas A. Edison School, Cleveland, Ohio.

The truant and misbehaving boy, who is sent to a central day school to receive an education adapted to his peculiar needs, is a utilitarian. He wants to know, "What good is it?" More than that he asks, "What good is it to me?" Adding the element of suspiciousness he is apt to think, "Why should they conspire to waste my time with something which will never do me any good?"

There is much virtue in his questioning. To meet his needs Cleveland has set up Thomas A. Edison school. Over a thousand boys are enrolled there now each year. Shops and academic work with a vocational flavor are provided for his education.

In science the regular units suggested by the city course of study are utilized whenever possible. Several of these units must, however, be displaced by ones having a more practical flavor. The problem boy sneers at the idea of studying about pretty butterflies but will work his head off when assigned a unit dealing with a possible future occupation.

Such a unit is the one on the metallurgy of iron and steel. The ordinary text (sad word) and reference books do not provide a wealth of material in this subject. As an introduction to the mimeographed material work sufficient for several weeks can be found in the ordinary general science text. We have four or five sets of these on hand for this purpose. The heavy work, however, must be given by means of mimeographed lesson pamphlets.

Before giving the content of this mimeographed material it will be well to give more facts regarding the boys themselves and the methods of teaching used. The I. Q. range is from 59 to over 120 with a median of 88. In the range from 70—79 occurs 205 of the boys and from 80—89 we find 264 of the boys from the school as a whole. One-fifth of the school consists of the eighth grade. Obviously some method of providing for individual differences is necessary. This is done in these ways: 1. By provision for differences in abilities and rates of working speed. 2. By provision for differences in aims, interests

and needs. 3. By provision for new entrants (120 per month for the whole school). More specific information regarding these facts may be gained from an examination of the unit on Iron and Steel which is given here.

IRON AND STEEL.

Uses.

The most important metal in industry is iron. It has more uses in the world than gold or silver. To get an idea of the many uses for iron as compared to other metals you are asked to list here some uses for the metal.

Think of the things in this school which are made of iron or steel. Then list them in the correct column. Do the same for gold and copper. If you cannot get five of each do not worry.

Iron (or steel.)	*Gold.*	*Copper (brass)*
1.	1.	1.
2.	2.	2.
3.	3.	3.
4.	4.	4.
5.	5.	5.
6.		
7.		

Which metal has the most uses?..

The chief manufacturing industry of Ohio in 1925 was iron and steel. Almost a billion dollars worth of iron and steel were made in Ohio in that year. The next most important was rubber tires and tubes to the value of over half a billion dollars while automobiles and auto parts ran a close third. The metal industries employ nearly half the workers in Cleveland manufacturing industries. You have or will learn about the opportunities for work in these industries in your social science work. Our purpose is to present the science of the subject as it is concerned with iron and steel. There is a close tie-up between the two.

Iron Ore.

The iron of commerce is produced from iron ore. Iron ore is not pure iron. It does not look like iron. Iron ore is a compound of iron with some other substance.

The four most important ores of iron are:

1. Hematite which is composed of iron and oxygen in chemical union. Its chemical name is ferric oxide (pronounced fĕrr′ ĭc ŏx′ īd).

2. Magnetite, Siderite, Limonite and others.

Examine a piece of iron ore.

What is its name?..

What is its color?..

Does it look like iron?..

Does it look more like iron rust than iron?........................

Iron ore is found in the territory bordering on Lake Superior in the States of Minnesota, Wisconsin and Michigan. The iron ore used in Cleveland comes from this region. Iron mines are also found in Alabama and other States. Cleveland, in 1923, received about nine million tons of ore by boat from the Lake Superior district. About one-third of this ore was for use by Cleveland plants. The other two-thirds was sent by boat to other cities. The chief ore of this Superior district is hematite (pronounced hĕm′ a tīt).

We have learned that hematite is a compound of iron and oxygen. It is possible to make a compound of iron and oxygen in the laboratory. In performing this experiment you should work with four or five others in order to save materials.

Your group will need the following materials: 1 test tube, 1 beaker, 1 ring stand with test tube clamp and a small pinch of iron filings. When you have these materials you may do the experiment in the following steps:

1. Fill the test tube with water. Pour the water out.

2. Scatter the iron filings over the inside of the wet test tube.

3. Fill the beaker with water. Invert the test tube over the beaker with the open end just below the level of the water as in the drawing. Clamp the test tube in this position. When completed your apparatus should resemble the drawing.

4. Set your apparatus aside until the next science period. Be sure your name is on it.

5. At the next class period examine the iron filings and write in the answers to these questions:

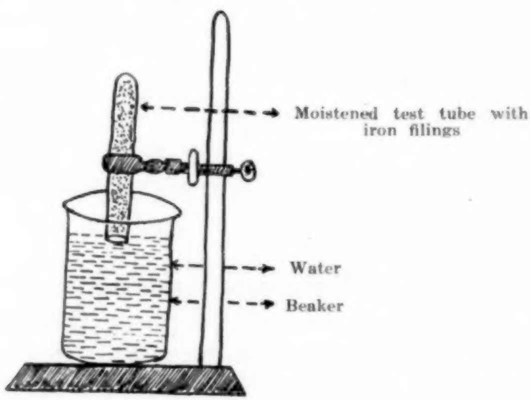
a. What is the color of the iron filings?........................

b. The iron has combined with some of the oxygen from the air in the test tube. Why has the water risen in the test tube?..

c. What is the chemical name of hematite? (Look back over the previous discussion for the answer to this) ....

d. From the appearance of the material in the test tube do you think that it contains ferric oxide?..................

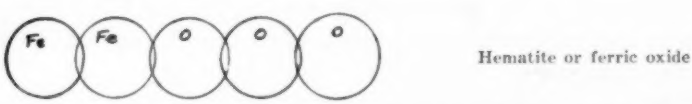
e. Hematite iron ore is composed of iron plus...............



The material which you have produced is ordinary iron rust.

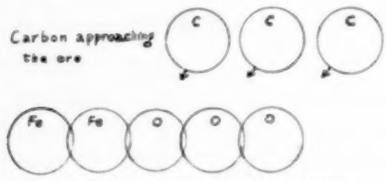
Reduction.

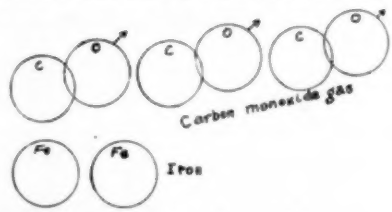
Getting the iron from its ore is known as smelting or reduction. We have learned that hematite is a compound of iron with oxygen. In the form of a diagram it might be represented as follows (iron is represented as Fe. Oxygen as O.) :



We can see from the diagram that the iron and oxygen are bound together to form an altogether different substance. We know that iron is a metal and that oxygen is a gas. How can we take this oxygen away from the iron? That is the question which this section will answer for you.

Carbon, in the form of coke, is used to take the oxygen away from the iron. Coke is a kind of carbon. At a high temperature oxygen likes carbon better than it does iron. Carbon will take the oxygen right away from the iron and fly away with it at a temperature of about 2200 degrees or over ten times as hot as boiling water. This may be represented by these diagrams. (Iron is Fe. Oxygen is O. Carbon is C.)





What took away the oxygen from the ferric oxide or hematite? ....

What was left behind? ....

The process may be illustrated by using lead oxide and charcoal. We cannot reduce iron ore in this laboratory because of the high temperature required. We can, however, reduce lead ore (take the oxygen away from the lead). The principle is the same.

You will need the following materials for this experiment: a pinch of lead oxide, a Bunsen burner, a small block of charcoal and a blowpipe. After you get these materials and two other boys to work with you, you may do the experiment in the following steps:

1. Hollow out a small hole a quarter of an inch deep in the charcoal. Place your lead oxide in this hole.

2. Light your Bunsen burner. Blow the flame against the lead oxide in the charcoal by means of the blowpipe. Continue blowing meanwhile watching the change taking place in the oxide.

3. Answer these questions:

a. What is the color of the material on the outside of the oxide? ....

b. Is this lead? ....

c. What did the lead oxide lose? ....

d. What took the oxygen away from the lead oxide?

....

e. With what did the oxygen unite?..............................

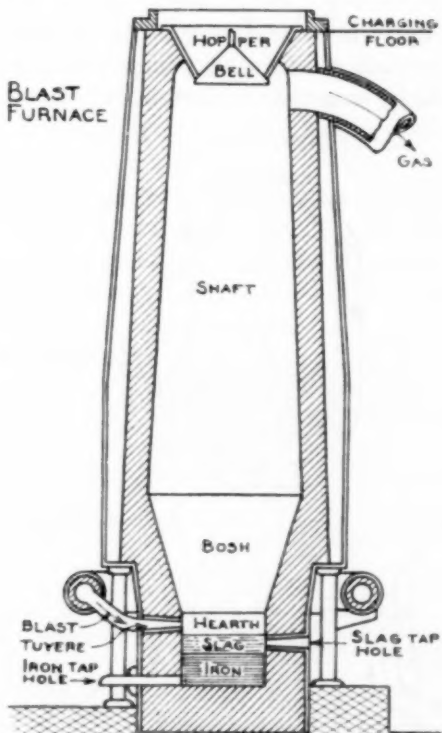
f. What metal was left behind?..............................

You have reduced the lead oxide to lead.

A similar experiment may be performed using cupric oxide to obtain copper.

Blast Furnace.

In industry iron ore is reduced in a blast furnace. The chemical process is essentially the one we have been explaining. Carbon in the form of coke is used to take the oxygen away from the iron ore. Iron ore contains other materials besides ferric oxide. To remove these materials a *flux* is added which is usually *limestone.* The limestone unites with these other materials to produce *slag.* The diagram below will show you what happens in the blast furnace. Study this diagram carefully and write out the answers to the questions which appear below it.



Hopper and bell through which the ore, coke, and limestone are dumped.

Downcomer, through which the heated gases are carried to the stove.

Iron ore, flux, (limestone) and coke.

Melted iron drops through.

Bustle pipe carrying hot air from stove.

—*Courtesy Dept. Vocational and Practical Arts, Cleveland Public Schools.*

Answer these questions on the lines at the right:

1. What is the name of this furnace?........................
2. What materials are dumped into it?........................
3. Through what do these materials enter?........................

........................and........................

4. What three things leave the furnace?........................,

........................, and........................

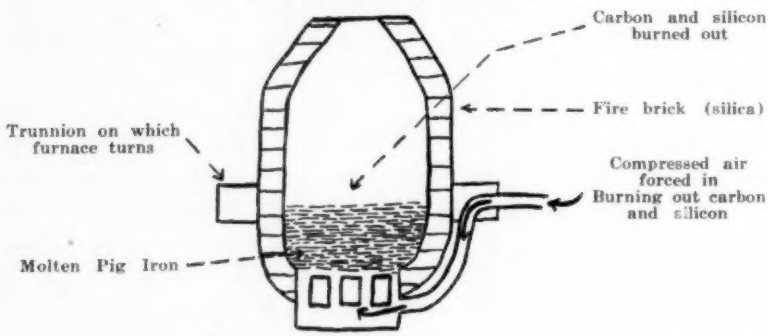
5. Through what do the hot gases leave?........................
6. Through what does the slag leave?........................
7. Through what does the iron leave?........................
8. What pipes carry hot air from stove to furnace?

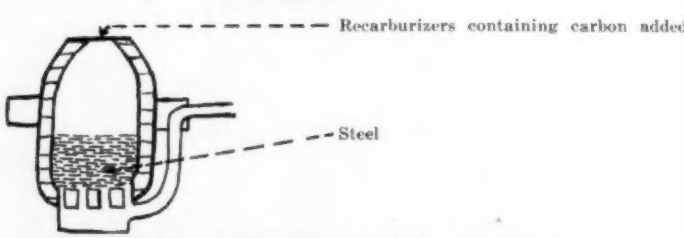
........................and........................

Making Steel.

Steel is made from the product of the blast furnace. The commonest process is the Acid Bessemer. The furnace used in this process is called the *converter*. Pig iron is put into the furnace, compressed air is forced in and carbon and silicon is burned out. After the air blast is turned off materials containing carbon are added to give the steel the right amount of carbon.

ACID BESSEMER PROCESS.





Answer these questions on the lines at the right:

1. What form of iron is put into the converter?............

2. What is the furnace lined with?..................................

3. What is burned out of the cast iron?.........................
and...

4. After the air blast is turned off what is put into the converter?..

5. What is the name of the part on which the converter revolves when it turns over?..............................

6. What is the product made in the converter?............

Teeming.

The steel is run from the converter into the ladle from which it is poured into ingot moulds. This is an important part of the manufacture of steel because of the great chance for waste due to bad places which come during the cooling process. Due to uneven cooling there is formed in the top of the ingot a cavity or "pipe." This pipe has been reduced in size by the use of the Gathmann mold.

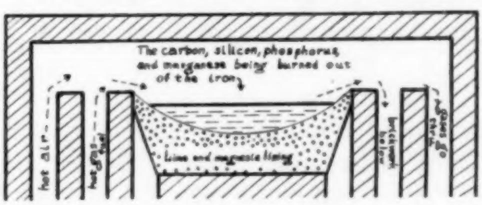
Another defect is the presence of blowholes or cavities due to the presence of gases which cannot escape. To prevent this the steel must have these gases removed before teeming. Stick aluminum is often put into the ingot to remove the oxygen gas.

The steel may develop ingotism (coarse crystals) or segregation (uneven mixture of iron and other materials) unless it is cooled quickly enough. Improper pouring of the metal from the ladle into the mould may cause the development of checks and scabs.

Basic Open-Hearth Process.

The basic open-hearth process is another method of making steel. It takes longer but is able to remove the phosphorus and other materials. A better quality of steel may be made from pig iron containing phosphorus when the open-hearth process is used. The acid Bessemer proc-

DIAGRAM OF OPEN HEARTH IN PART.



ess does not remove the phosphorus. The basic open-hearth does remove it. Furthermore, it is easier to burn out just the right amount of carbon. There is also less danger of overheating the metal.

Study the diagram and answer the questions which follow.

The steel is later poured out into ladles.

1. What fuel is used?
2. With what is the hearth lined?................................ and..
3. What materials are taken from the iron in this process?................, ..., ..., and................
4. What is the product of the open-hearth?....................

Carbon is added to steel to make it harder and stronger. Lack of carbon makes steel very soft.

Alloy Steels.

Other elements when added to steel in the converter or open hearth give it different qualities. Steel containing a tiny amount of vanadium is used in automobile parts. Chromium, tungsten or molybdenum may be added to steel if it is to be used for high-speed lathe tools. For burglar-proof safes a steel containing manganese is used. A steel containing nickel is used for armor plate or for measuring instruments. Titanium steel is used for car rails and steel castings. Duriron, or steel containing silicon, is used for making cars which carry acids. These elements, when added to steel in the furnace, give it the character it needs to do the job it is to do. Steel which contains another metal is called an alloy steel.

Electric Furnace.

The production of steel by the electric furnace has been steadily increasing in the United States. The heat for the furnace is furnished by an electric arc. The chief materials removed in the process are oxygen and sulphur. It is often used to supplement the Bessemer or open-hearth process.

Heat-Treatment of Steel.

If steel is cooled quickly it becomes very hard. If it is cooled slowly it becomes softer. In order to machine some steels it is necessary to reheat and then slowly cool

them. This process of making the steel softer by heating and then slowly cooling is known as *annealing*. Annealed steel is easier to cut into the shapes in which it is wanted.

Steel is hardened by being heated to a high temperature and then quickly cooled. If the steel is gradually reheated to a definite temperature and then quenched the degree of hardness can be regulated. For example, steel heated to a temperature of 450° and then suddenly cooled is used for razor blades. This process is known as *tempering*.

Steel which has a low carbon content may be case hardened. By one of several processes carbon is added to the surface of the steel and the piece hardened. Case hardening gives the steel a hard surface.

Oil treating is often used to increase the strength of steel. In this process the heated steel is plunged into an oil bath. This makes the steel tougher.

You will need an 8 penny finishing nail, a pair of tongs, a Bunsen burner and a beaker of water.

1. Try to bend the 8 penny nail with your fingers. If you are able to bend this nail get a larger sized nail and begin again.

2. Heat the nail over a Bunsen burner until it is red hot. Heat it just as hot as you can. Hold it with the tongs.

3. Let it cool slowly by holding it a few inches from the burner as it cools.

4. Try to bend it as soon as it is cool enough to touch. B careful not to burn your fingers. Your first attempts to touch it should be made with moistened finger tips. The nail should bend. If it does not bend you should get a smaller sized nail and begin again. The fact that the nail bends when it would not do so originally shows that you have annealed it.

5. Straighten the nail and reheat it to redness as before. When very red hot plunge it swiftly into a beaker of water. Try to bend it again. What have you done to the nail?..

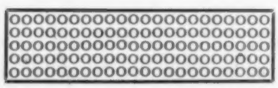
Mechanical Treatment of Steel.

The hammering and rolling of steel gives it not only a different shape but also a different character. If steel is

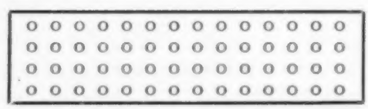
worked while hot it will become softer. It will stand a hammer blow better but will not be so strong. If cold worked (below the critical range) it will become harder and stronger but at the same time it will break more easily under a blow.

Welding and Cutting.

All things are made of molecules. These molecules are so small that nobody has ever seen one. Millions of them could be placed upon the point of a pin. In the picture below we have drawn a steel bar with the molecules. Of course the molecules are not so large as they are drawn in the picture. The drawing shows that the molecules in a cold steel bar are close together. When the steel bar is heated the molecules become more active, take up more space and the bar thus becomes larger. Iron or steel, when heated, becomes larger. The drawings showing the molecules explains why.



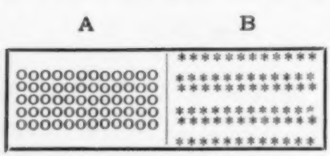
MOLECULES CLOSE TOGETHER IN COLD STEEL BAR



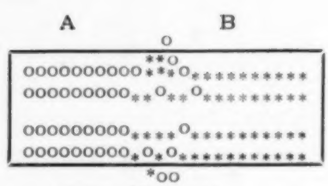
MOLECULES SPACED FARTHER APART IN A HEATED STEEL BAR. NOTE THAT THIS BAR IS THE LARGER.

Why is the second bar larger than the first?..................

Advantage is taken of this fact in the process of welding. When the two pieces of steel to be joined are heated the molecules become more active, take up more space and begin to move past each other. Some molecules in piece A trade places with some molecules in piece B. Hot molecules move faster.



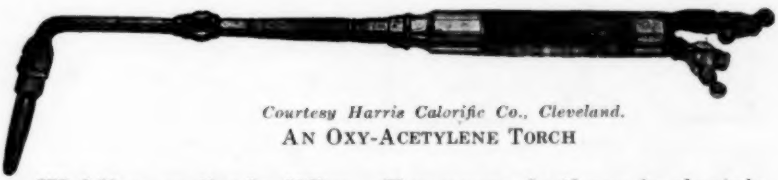
BEFORE HEATING



AFTER HEATING

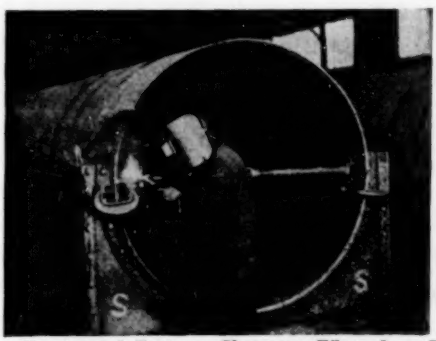
The facts above may be stated in a simpler form. We know that water is a liquid. When two streams of water meet they join together or "weld." When steel is heated

to a very high temperature it also becomes a liquid. If hot enough it will flow like water. Two streams of liquid steel will join together just as will two drops of water. To heat the ends of the two steel pieces electricity or acetylene is used. In the case of thick pieces the edges are beveled and a filler used.



Courtesy Harris Calorific Co., Cleveland.
AN OXY-ACETYLENE TORCH

Welding methods differ. For example there is electric resistance welding which uses both heat and pressure. Electric arc welding depends upon the heat produced by electricity only. In oxy-acetylene welding the worker uses a torch. Heat is generated by burning acetylene gas as it combines with oxygen. With a regular cutting torch acetylene and oxygen are used to cut apart steel pieces. In the thermite or Goldschmidt welding process aluminum is used to take oxygen away from an oxide of iron and to supply heat to melt the metal which is to fill the break.



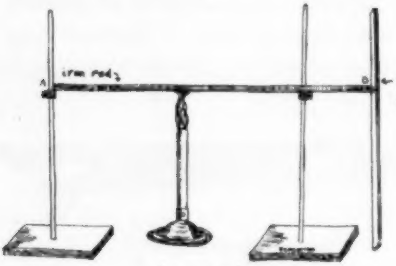
Courtesy of Eastman Classroom Films, Inc., Rochester, N. Y.
CUTTING IRON WITH AN ELECTRIC TORCH

Properties.

Expansion. You have learned that a piece of metal will grow larger when heated. This is called expansion. The following experiment will prove the truth of this to you.

Materials necessary to do the experiment: Two ring stands with rings, Bunsen burner, an iron or steel rod and a ruler.

1. Set up the apparatus as in the drawing with the iron rod resting on the rings.



2. Set the ruler against the end of the rod at B so that it will just fall over if a pencil is lightly tapped against the ring stand at A.

3. With the ruler in position again heat the iron or steel rod in the middle with a Bunsen burner.

4. What happens to the ruler?..

5. What did the iron or steel do when heated?.............

Specific Gravity.

A bar of steel will not have the same weight as a bar of cast iron the same size. The steel bar will be a little heavier. White cast iron is 7.655 times as heavy as an equal volume of water. We say, therefore, that the *specific gravity* of white cast iron is 7.655. Wrought iron is 7.698 times as heavy as an equal volume of water. Its specific gravity is 7.698, of course. Steel is 7.816 times as heavy as water. What is its specific gravity?.................

Conduction.

Steel and iron are good conductors of heat. To show this, perform the following experiment:

Materials you will need: Bunsen burner, glass rod, steel rod.

1. Hold the end of the steel rod in the flame of the burner. Your hand should be about 6 or 8 inches from the flame. What happens?..

2. Hold one end of the glass rod in the flame of the burner. Your hand should be about 6 or 8 inches from the flame.

What difference do you note?...

Which is the better conductor of heat?............................

("Conductor" of heat means "carrier" of heat.)

Elasticity.

If we stretch a rubber band it will fly back into its original shape. This property which the rubber band has of returning to its original shape is known as elasticity. Steel has a high elastic limit. If we bend a steel spring it will return to its original shape unless we apply too much weight. In bending the spring we are applying a *stress* and we say that the steel is being *strained.* If we apply a stress twice as great the strain will be twice as great. Two tons will produce twice as much strain on one's truck springs as will one ton.

Tensile Strength.

If we pull on the opposite ends of a strip of paper we can pull it in two. We say that its tensile strength is not great enough to prevent us from pulling it apart. The tensile strength of a thing is usually given as the number of pounds of weight necessary to pull it apart when it is an inch wide and an inch thick. Thus it would take but a 9,000 lb. weight to break a manila rope in two but it would require 37,000 lbs. to tear apart a wire rope if they both were one square inch in area at their ends.

Malleability. If a metal can be rolled or hammered into thin sheets it is said to be malleable. Steel, when hot, is run through huge rollers to make steel sheets. Malleable iron is made from cast iron by a process which removes part of the carbon content. Gold is more malleable than any other substance. It can be hammered into thinner sheets.

Hardness and Brittleness. We can tell which of two things are the harder by scratching one with the other. The diamond is the hardest substance known because it will scratch all other materials. Steel is made hard in the process of heat treatment. Scratch hardness is one of several kinds of hardness.

Brittleness is different from hardness. If a thing is apt to break when hit a blow it is said to be brittle. Glass is both hard and brittle while steel is hard and tough. We can test the brittleness of glass and steel by seeing which will break more easily when hit a blow with a hammer.

We can test their hardness by scratching one with the other.

Magnetic Properties. In practical work iron and steel are the only substances used in the making of magnets. Many shops use huge electromagnets to pick up and carry iron and steel pieces. This is done with no other material. You will learn more about magnets and electromagnets in a later grade. Suffice it to say that without the magnetic properties of iron we would not have our electric motors and generators.

Things You Will Need to Know in Order to Pass a Test.

You will be given two tests over Iron and Steel. The first test will be the storekeeper's test. This test is in the nature of a practice test and will be given and marked by the storekeeper. The second test is the teacher's test. It will be given and marked by the teacher. To be eligible for taking the teacher's test you must pass the storekeeper's test with a mark of 100%. Several trials on equivalent forms of the storekeeper's test will be given you after reviewing if you do not succeed the first time.

Before undertaking the storekeeper's test it will save time for you if you are thoroughly prepared on the following items:

1. Importance of iron and steel in manufacturing and employment compared to others.
2. Ores of iron. Names. Where found.
3. Chemical name of hematite. Of what composed.
4. Reduction. Smelting. Chemical explanation.
5. Blast furnace. Materials put into furnace. Materials taken out of furnace. Parts of blast furnace. What happens in the furnace. Chemistry of the blast furnace.
6. Pigs.
7. How steel differs from pig iron.
8. Acid Bessemer process. Parts of the converter. What happens in the converter. What is taken out.
9. Teeming. Why important. Imperfections.
10. Basic Open-Hearth process. Compare with Bessemer process. Parts of the hearth. What happens? What is the product of the open-hearth?
11. Materials added to steel. Carbon. Alloy steels. Why added?
12. Electric furnace. Growth of process. Arc. Materials removed.
13. Heat-treatment. Annealing. Hardening. Tempering. Case-hardening. Oil-treating. Effects of each kind of treatment.
14. Mechanical treatment of steel. Hot and cold working and effects of each on the steel.
15. Welding and cutting. Molecules. What happens when iron or steel is heated? Methods of welding.
16. Properties of iron and steel: expansion, specific gravity, conduction of heat, elasticity, tensile strength, malleability, hardness, brittleness, magnetic.

Extra Work for Extra Credit.

Those who finish the minimum requirements before others may undertake extra work for extra credit. Here are some suggested references:

Corre—The Metal Industries in Cleveland.

I. C. S. Staff—Heat Treatment Appliances and Processes (Public Library).

Berg and Wing—Essentials of Metalworking.
Smith—The Story of Iron and Steel.
Page—Modern Welding Methods.
Cooley—Rodgers and Melman—My Life Work—Building and Metal Trades.

Hard Words Made Easier

Acetylene—a hot burning gas formed by adding water to calcium carbide
Acid—opposite of base.
Alloy—two or more metals melted together as one.
Anneal—to soften.
Arc—part of a circle.
Apparatus—outfit.
Basic—opposite of acid.
Brittle—easily broken.
Calcium silicate—one material in slag.
Carbon—an element we see as coal, coke, diamond, etc.
Carbon dioxide—a gas composed of carbon and oxygen.
Carbon monoxide—a poisonous gas which burns easily.
Case hardening—surface hardening.
Cast—given shape in a mold.
Cavity—hole.
Compound—chemical union. Materials joined together chemically.
Conductor—carrier.
Critical range—exact points.
Crystal—a shape in which materials may form. Has no round points.
Cupric—contains copper.
Defect—fault.
Element—a simple material which cannot be divided into other materials.
Expansion—growing larger.
Ferric—iron containing.
Flux—material which will combine with an unwanted material and flow out with it.
Generated—made, produced.
Gravity—the force which pulls things downward and gives them weight.
Industry—business of making things.
Ladle—huge bucket.
Lathe—machine which shapes iron by cutting off unwanted parts.
Liquid—material which flows like water.
Molecule—very tiny part.
Manufacturing—what a factory does.
Original—first.
Oxide—contains oxygen.
Oxygen—a gas which forms part of the air. It is found in hematite, etc.
Ore—a material which is mined so that a metal may be taken from it.
Phosphorus—an impurity which is found in iron ore.
Principle—idea, rule.
Process—method.
Reduced—made smaller, something taken away.
Reduction—getting a metal from its ore.
Represented as—shown as.
Silica—fire brick.
Silicon—element found in sand.
Slag—a glassy material.
Smelting—getting a metal from its ore.
Substance—material.
Supplement—help or add to.
Tap—door, pipe or trough.
Teeming—pouring into molds and cooling.

Temper—to make a certain hardness.
Trunnion—axle.
Tuyeres—pipes.
Volume—space occupied.

A DIRECT DETERMINATION OF THE VELOCITY OF SOUND.

By N. F. Smith,
The Citadel, Charleston, S. C.

In a laboratory course in sound there seems to be a distinct need for a direct determination of its velocity. This important physical constant is usually determined indirectly by a measurement of wave-length and frequency. If a direct method is employed it is based on the determination of the time required for a loud sound to travel a distance sufficiently great to permit the use of a stop-watch. The inaccuracy of this method is such that it can only be regarded as approximate, and the inconvenience is so great that it is seldom attempted. The following method has been used successfully by students in one of the physics courses at The Citadel. It has the advantage of absolute directness. It is reasonably simple in manipulation. It arouses the interest of the student; and it yields results of sufficient accuracy to make it a suitable research method if such were desired.

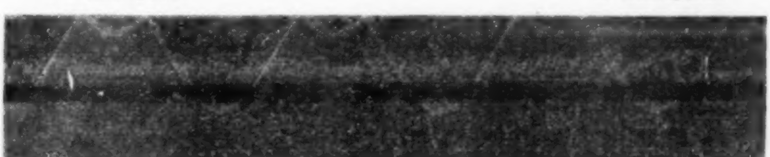
In brief outline, the method was as follows: Two microphones were mounted about five feet above the floor near the opposite ends of a long hall. These were connected in series with a six-volt battery and a Westinghouse oscillograph. A paper cap, such as is used with toy pistols, was exploded about five or six feet in front of the first microphone. As the sound wave struck the two microphones in succession, it caused a sudden and marked change in the current flowing in the circuit. This was recorded photographically on the revolving film of the oscillograph. To determine the time element, a curve produced by sixty-cycle alternating current was superimposed upon the film. The measurements involved were simply the distance between the two microphones, the length covered by a known number of cycles on the film, and the distance on the film between the two marks caused by the wave when it reached each of the two microphones. The last two measurements gave the time required for the sound to travel from one microphone to the other. It will be noticed that no error is

introduced because of any time lag due to the action of the diaphrams or the inductance of the circuit, since this lag affects each change in current equally.

Certain details in the experiment will be helpful to any one attempting to repeat it. The explosion must occur at such a time that the sound wave will reach the first microphone when the film is near the beginning of its revolution. The film must be illuminated by the lamp of the oscillograph through one revolution, only. The speed of the film must be kept constant while the sound wave and the sixty-cycle curve are being recorded. As carried out in this laboratory, the drum of the film-holder was driven by a belt connected to a synchronous speed motor. The cap was exploded by a hammer released by a telegraph relay. The operator pressed a contact key in the relay circuit which was then automatically closed by a revolving switch attached to the shaft of the drum, thus producing the explosion at any desired instant with reference to the position of the rotating drum. An adjusting screw provided a means of regulating this time, and the correct setting was found by trial. The light in the oscillograph was automatically turned on and off so as to illuminate the film through a single revolution. With the apparatus once set up and adjusted, the entire operation was automatic, the operator merely needing to start the motor, open the shutter, and press the contact key. Changing a single switch on the oscillograph, then permitted the superimposing of the sixty-cycle curve.

The accompanying photograph is one of several taken. Three or four exposures may be made on the same film by moving the lamp in the oscillograph. The different sixty-cycle curves partially overlapped, as seen in the photograph. The two points marked by white lines on the photograph indicate the times at which the sound wave reached the first and second microphones respectively. The following data

1st Microphone 2d Microphone



KUNDT'S TUBE COMBINED WITH THE HELMHOLTZ SIREN

are taken from two independent records:

Distance between microphones, 1678 cm.
Temperature, 18° C.
Computed velocity at $18° = 331.7 + .6 \times 18 = 342.5$ meters/sec
From first photographic record:
Length of 5 cycles on film, 24.2 cm.
Distance on film between impact marks due to first and second microphones, 14.15 cm.
If x equals time required for sound to travel from first microphone to second, then
$24.2 : 14.15 :: 5/60 : x$
Whence $x = .04872$ seconds, and the velocity of sound
$V = 16.78 \div .04872 = 344.4$ meters/sec.
From second photographic record:
Length of 5 cycles on film, 24.25 cm.
Distance between impact marks, 14.25 cm.
$24.25 : 14.25 :: 5/60 : x$
$x = .04896$ seconds.
Velocity $= 16.78 \div .04896 = 342.7$ meters/sec.

It is probable that the accuracy of the results could be increased by increasing the distance between the two microphones. With a belt connection between drum and motor, there is always a possibility of slight variations in speed due to slipping of the belt. Since the sound record and the sixty-cycle curve were obtained within a few seconds of each other, it is not probable that this introduced any considerable error. Any variation in the frequency of the alternating current from the rated sixty cycles would, of course introduce a proportional error in the determination of velocity. This is probably less than a tenth of one per cent. The sound produced by the explosion of the cap consists, not of a single pulse, but of an irregular succession of waves, highly damped. The effect upon the first microphone had not entirely died out when the disturbance reached the second. It is probable that the discharge of a condenser, such as a large battery of Leyden jars, would afford a more satisfactory source of sound. This method was tried, but failed because of lack of sufficient intensity of the sound with the apparatus which was available.

ECUADORIAN "SILK FLOWER" MAY SUPPLY NEW TEXTILES.

A tall bush with bright yellow and red flowers, bearing long silky fibers in its pods, may be the source of new textiles, in the opinion of Dr. A. Avila of Guayaquil, who has been investigating its properties. It grows in the tropical forests of the Ecuadorian mountains, where it is known to the natives as the "silk flower." It belongs to the euphorbia or spurge family, being related to such well-known plants as the Para rubber tree, the castor bean, and the poinsettias used in Christmas decorations.

MEASURING THE FREQUENCY OF AN A. C. LIGHTING CIRCUIT BY MEANS OF A NEON GLOW LAMP.

By J. IRVIN SWIGART,

Bethany College, Bethany, West Virginia.

A method for measuring the frequency of an A. C. lighting circuit, which uses a neon glow lamp and a variable speed stroboscope, has proved to be very simple and remarkably accurate.

A disc made of heavy bristol board with alternate sectors of black and white, as shown in fig. 1, is placed upon the shaft of a variable speed rotator and illuminated by a neon glow lamp which is lighted by the A. C. whose frequency is to be measured. The speed of the disc is gradually increased from 0 until the sectors on the rotating disc appear stationary and sharply defined. The speed at

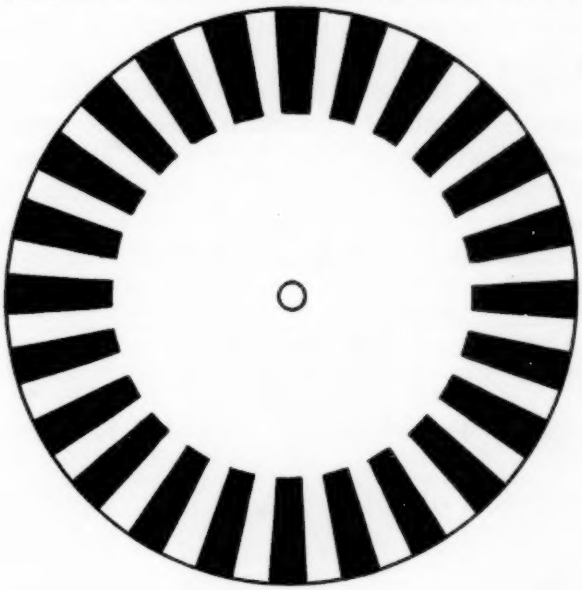


Fig. 1

which the sectors appear stationary is maintained and the number of revolutions is recorded for a period of from one to five minutes. The frequency of the A. C. can be calculated from these data by means of the following formula:

$$f = \frac{NR}{T}$$

where,

f = frequency of A. C.

N = the number of black sectors on the disc.

R = number of revolutions of disc per second.

I = number of light impulses per cycle illuminating the disc.

The description of the phenomenon involved depends upon the rapidity with which the neon glow lamp can be lighted and extinguished. This lamp consists of two electrodes insulated from each other in a glass bulb containing rarefied neon. If the potential difference between the two electrodes is less than 140 volts (approximately) the lamp is not lighted. If the potential difference exceeds 140 volts the negative electrode glows brilliantly and remains lighted so long as the potential difference is kept above 140 volts. If the polarity is reversed the other electrode (which then becomes negative) glows and the positive remains unlighted. Now, if the lamp is connected across the 110 volt A. C. lighting circuit, the potential difference between the electrodes changes from 0 to 155.5 volts, decreases to 0, reverses and reaches 155.5 volts in the opposite direction and returns to 0 again during each cycle, as shown by the sine curve in fig. 2. Each electrode of the neon lamp

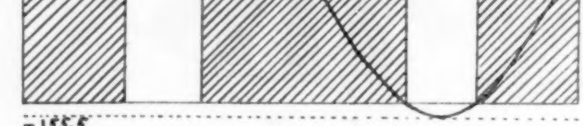


Fig. 2.

glows once each cycle as shown by the unshaded area in fig. 2. The shaded area shows the periods of darkness during each cycle.

Thus there are two flashes of light and two much longer periods of darkness per cycle. At each flash of the lamp an instantaneous image of the rotating disc is obtained.

The speed of the disc is adjusted so that during the period of darkness each black sector moves to such a position that when the lamp again glows it will occupy the place which the preceding black sector occupied at the time of the last succeeding glow. This series of instantaneous images will appear as if the disc were stationary.

A disc 20 cm. in diameter with 24 equally spaced black sectors as shown in fig. 1 has been employed in the elementary laboratory with surprisingly good results. Any electric lamp will vary in intensity when operated on A. C. and therefore this experiment may be performed with an ordinary filament type lamp. However, the filament is never entirely extinguished during the cycle and the image will not be nearly as well defined as when the neon glow lamp is used.

FROM THE SCRAPBOOK OF A TEACHER OF SCIENCE.

By Duane Roller,

The University of Oklahoma, Norman, Okla.

Fear not that thy life shall come to an end, but rather fear that it shall never have a beginning.—*Cardinal Newman.*

I am not so lost in lexicography as to forget that words are the daughters of earth, and things are the sons of heaven.—*Samuel Johnson.*

These volumes "in which there is so much discussion of nature that it is no longer necessary to go and look at it."—*Princesse Marthe Bibesco, in "Egyptian Day."*

The book of Nature is a fine and large piece of tapestry rolled up, which we are not able to see all at once, but must be content to wait for the discovery of its beauty and symmetry, little by little, as it gradually comes to be more unfolded or displayed.—*Robert Boyle, in "The Christian Virtuoso."*

The birch, most shy and ladylike of trees.—*James Russell Lowell.*

I'm constant as the Northern Star,
Of whose true-fixed and vesting quality
There is no fellow in the firmament.
—*Shakespeare.*

In the Twentieth Century war will be dead, the scaffold will be dead, hatred will be dead, frontier boundaries will be dead; man will live. He will possess something higher than all these—a great country, the whole earth, and a great hope, the whole heaven.—*Victor Hugo.*

A CLASSROOM DEMONSTRATION WITH A STROBOSCOPE.

By JACOB W. MOELK,

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Why do the spokes of wheels always seem to be running backward in the movies? What is happening in an electric light bulb through which an alternating current is passing?

These and other questions can be cleared up quite easily and in an interesting manner by the use of the stroboscope. The accompanying diagram (see Fig. 1 of the preceding article) shows how very simple the device is. The black strips, about a half inch wide and two inches long, were inked on a disc of white cardboard one foot in diameter.

The disc is mounted on the shaft of a rotator and an electric light is placed so that the card is strongly illuminated by it. The lamp should be shaded from the eyes of the class. As the speed of rotation slowly increases, the grayish blur changes to a series of black lines which seem to be rotating in the opposite direction to that of the disc. As the speed is increased still further, the rotation of the lines seems to slow up and stop, but with still greater speed they acquire velocity in the direction of rotation of the disc. This is explained by the fact that the filament of the light is glowing brightly one hundred twenty times every second (in a sixty cycle current) and is relatively dark a like number of times every second. If the disc is going fast enough so that a given black strip has time to come up during a period of no illumination and take the same position formerly held by the preceding black strip while there was light, then during the next fraction of a second when there is light on the disc there will be no apparent shifting of the strips. If the light is turned off and the disc is illuminated by daylight, the whirling, no matter how fast, will produce only a blur.

Simple and interesting problems can be given by the instructor in connection with the demonstration. When the disc is illuminated by the lamp and is rotating at a speed sufficient to produce no apparent motion of the strips:

The number of alterations of the current per minute = the number of black strips $\times$ the number of rotations of the disc per minute.

INTRODUCING FORMULAS AND EQUATIONS TO THE CHEMISTRY BEGINNER.

BY FRANCIS C. COULSON,
Crane High School, Chicago.

K
Na
Li
Ba
Sr
Ca
Mg
Al
Mn
Zn
Cr
Cd
Fe
Co
Ni
Sn
Pb
H
Cu
As
Bi
Sb
Hg
Ag
Pt
Au

Inspection of articles in chemical and science journals dealing with teaching beginning chemistry seems to point out in questionnaire studies on pupil difficulties and on chemistry subject matter most difficult to teach that the three greatest difficulties experienced are equations, valence and mathematics. The existence of those difficulties is accounted for somewhat as being perhaps due to the traditional method of presenting formulas and equations "later on in the course," in other words after several weeks of chemistry have passed and then presented all in one lump too large for most beginners to swallow. Valence, formulas and equations will offer little difficulty to the majority of pupils if those things are presented in sequential bits directly from the beginning of the course in chemistry and if those bits are allowed to be "masticated" thoroughly by very frequent drills. A workable knowledge of equations is based on understanding how to construct formulas and that in turn on valence. The major part of the mathematics in chemistry is the chemical arithmetic dealing with the different kinds of problems from equations. If a pupil can write equations well, there is not much difficulty in constructing the proportions based on the equation ratio in problems from equations.

An excellent way to put over formulas and equations and at the same time to minimize pupil discouragement is to base those two very necessary tools on the activity series of metals shown in the margin. Through its use so durable a foundation in formulas can be developed the first few weeks of chemistry that little trouble is experienced thereafter. It is unsound procedure to start the chemistry beginner memorizing a number of a formula for it is very discouraging at the beginning and it will defeat the proper method of making formulas by construction later on. A few fea-

tures in the manipulation of the activity of metals column will now be considered.

The first few days in beginning chemistry are usually spent in endeavoring to have the pupils acquire an introduction to the subject by learning a few useful terms and by learning to manipulate apparatus through the study of matter and its changes. Right at the beginning then, have the pupil memorize the symbols and common valences of three or four of the metals at the top of the list. Make suggestions for memorizing economically. Assign three or four for the next day and so on. It will be found that if the pupil is not assigned too much at the beginning he will from initiative advance beyond the teachers assignment. Some will be so far ahead as to get all the symbols and valences in the column memorized through emulation the first day or so. The pupils need not know the purpose of the valence right now. If he is informed that the matter will be taken up as soon as the symbols and their valences are memorized curiosity will serve as an urge to get the memorizing done soon. The root word for the elements having more than one valence should of course be memorized at the same time.

By the time the study of oxygen is started, the memorized radicals and valences will serve as an excellent background for beginning formula construction. Words for formula and word equations should be used in the oxygen experiment for such procedure will create a desire to know how to write formulas. The pupil will be anxious to try to write formulas and the experience gained in witnessing that elements combine with oxygen to form oxides is a stimulus. It is time then for an exercise on constructing and naming the oxides of the metals in the series. The pupil can learn the valences now for the four non-metals viz., oxygen, carbon, sulfur and phosphorus. Show how to construct formulas by using the lowest common multiple of the valences:

$$\mathrm{Al}\ \mathrm{O} \qquad \overset{3}{\mathrm{Al}}\ \overset{2}{\mathrm{O}} \qquad \overset{\overline{3\quad 2}^{\,6}}{\mathrm{Al}\ \mathrm{O}} \qquad \overset{\overline{3\ 2}^{\,6}}{\mathrm{Al_2O_3}}$$

It is recommended that the criss-cross method of obtaining subscripts should not be used for it does not apply in all cases and it develops a dependence on short cuts for the future.

Possessed with the knowledge of constructing formulas

of oxides the pupil will next be interested in writing equations for the oxide preparation, the simplest of the equations, a synthesis or combination. Let the type of chemical change be recognized if the pupil is to have ability in writing equations in the future. There is no hardship on the pupil embodied in learning right then that the gain in valence is considered oxidation and the loss in valence as reduction.

$$4\ \overset{0}{P} + 5\ \overset{0}{O}_2 \rightarrow 2\ \overset{5}{P}_2\overset{2}{O}_5$$

During the first formula construction attention should be called to the fact that the valences memorized are those exhibited by elements in combination.

An excellent scheme for motivation in presenting names and formulas of compounds is the use of flash cards. Making use of instinctive play and emulation with a game by dividing the class will be stimulating in the direction of more application. It recalls earlier learning days yet the pupils like the very beneficial drill of seeing the formula and hearing the name or seeing the name and hearing the formula. The card sets, one of formulas and one of names can be very conveniently used for short written tests or exercises.

By the time the study of hydrogen is nearly completed the pupil will again be interested in equations and it is then time to present the activity series of metals in relation to the action of dilute acids with the metals. An experiment supplementary to hydrogen involving the action of the common dilute acids with metals in the different sections of the activity list is very desirable. It is then a good time for the pupil to memorize the name, formula and valence of two or three more negative radicals, those of the dilute acids used. The pupil will become acquainted with another type of chemical change, substitution and the gain and loss of valence should also be impressed.

$$\overset{0}{Fe} + 2\ \overset{1}{H}\overset{1}{Cl} \rightarrow \overset{2}{Fe}\overset{1}{Cl}_2 + \overset{0}{H}_2\uparrow$$

The action of metals with water can be mentioned in connection with hydrogen but it is best studied under the chemical properties of water.

Before the study of hydrogen is completed, equations can further be driven home by considering the conduct of

the oxides of the metals in the activity series in respect to

1. Heat.

$$2\ \overset{2}{Hg}\overset{2}{O}\ \triangle \rightarrow 2\ \overset{0}{Hg} + \overset{0}{O}_2\uparrow$$

2. Reduction with hydrogen and with carbon.

$$\overset{2}{Cu}\overset{2}{O}\ \triangle + \overset{0}{H}_2 \rightarrow \overset{0}{Cu} + \overset{1}{H}_2\overset{2}{O}$$

$$2\ \overset{2}{Cu}\overset{2}{O}\ \triangle + \overset{0}{C} \rightarrow 2\ \overset{0}{Cu} + \overset{4}{C}\overset{2}{O}_2\uparrow$$

3. Reduction by another metal.

$$\overset{3}{Cr}_2\overset{2}{O}_3\ \triangle + 2\ \overset{0}{Al} \rightarrow \overset{3}{Al}_2\overset{2}{O}_3 + 2\ \overset{0}{Cr}$$

4. Electrolysis.

$$2\ \overset{3}{Al}_2\ \overset{2}{O}_3\ (D.\ C.) \rightarrow 4\ \overset{0}{Al} + 3\overset{0}{O}_2\uparrow$$

The pupil can see that oxygen gains valence by going from negative two up to zero. Reduction does not involve much extra work because the pupil should be already fairly well acquainted with oxides and oxidation. It is well to show the substitution by a metal higher in the series of a metal from its salt solution.

$$\overset{0}{Zn} + \overset{2}{Pb}(C_2\overset{1}{H}_3O_2)_2 \rightarrow \overset{2}{Zn}(C_2\overset{1}{H}_3O_2)_2 + \overset{0}{Pb}\downarrow$$

$$\overset{0}{Cu} + 2\ \overset{1}{Ag}\ \overset{1}{NO}_3 \rightarrow \overset{2}{Cu}(\overset{1}{NO}_3)_2 + 2\ \overset{0}{Ag}\downarrow$$

During the unit on water the activity series can be used to impress what metals react with cold water and what ones react with steam and during the unit on water it is well to drill on formulas and in addition to the oxide flash cards, additional ones containing names and also formulas of salts, viz., chlorates from the oxygen experiment and from the hydrogen experiment, sulfates, chlorides, acetates and possibly nitrates, will be acceptable. The ammonium radical can be introduced. It is observed then that the sequence should be first a few simple symbols or radicals and valences, then simple formulas, then simple equations, a few more radicals, then more expansive formulas, etc. The tendency should not be to hold formulas and equations from pupils until "later on in the course." By that time the pupils need to use formulas and equations regularly as a functioning device for expeditious chemistry understanding.

After the unit on water the pupil should memorize a few

more negative or acid radicals such as the following: carbonate, sulfite, sulfide, nitrate, phosphate, phosphite, oxalate, chromate, bromide and iodide. The pupil should learn to distinguish by name two acids containing the same non-metal such as H_2SO_4 and H_2SO_3, HNO_3 and HNO_2, H_3PO_4 and H_3PO_3 as well as the corresponding salts.

Nomenclature should be presented in bits early also instead of waiting until the study of acids, bases and salts. Flash cards are again useful. As the pupil has increased his or her ability in formula construction then the time is near for presenting the easy metathesis or double decomposition equation which pupils like. Balancing such equations should be taught by the method of the lowest common multiple of total positive valences on the right side of the equation. At the very introduction of equations and constantly thereafter it is very important that a pupil recognize what type of chemical change each equation represents; viz., synthesis or combination, analysis or decomposition, substitution, and double decomposition or metathesis.

The activity series of metals is very useful in the treatment of the action of nitric acid and of concentrated sulfuric acid on metals when the unit on metals is studied. Balancing such equations should be taught by the method of gain and loss of valence. The activity series serves as a skeleton upon which to build the study of metals not only because of its applications but also because of the apperceptive mass acquired through its early use.

The psychology in teaching beginning chemistry should be such that the subject matter is arranged in sequential fashion to allow the presentation of formulas and equations early in the course, and very simply at first. At the same time the appreciative and pandemic sides of chemistry should not be neglected. Formulas, equations and problems can be introduced to the chemistry beginner by the use of the activity series of the metals which can be used first for symbols and valence, next for formulas, then for equations especially through the study of oxygen and hydrogen. Problems from equations are simplified in accordance with the ability to write equations which in turn is dependent largely upon proper formula construction and that ability in turn is dependent upon memorizing radicals and valence.

LEARNING IN FIRST YEAR ALGEBRA.

By Nelson A. Jackson,

Mount Hermon School, Mount Hermon, Mass.

Is every boy who enters high school or preparatory school capable of learning algebra? Most mathematics teachers would answer this question negatively. Some few teachers in select private schools where only high-test boys of superior intelligence are admitted might give an affirmative answer. However, a boy with a high I. Q. is not always capable of grasping the facts of algebra. Such a case will be discussed later in this study.

If then some are predestined to fail in algebra, is it possible with any degree of certainty to determine in advance who they are? If this can be done, many pupils may be spared long, weary hours of fruitless, discouraging toil and in some instances directed so that the forming of the devastating habit of failure may be avoided.

It would seem that if any attempt is to be made to guide into other courses pupils who apparently lack algebraic ability, the teacher's judgment is the one most dependable factor for such guidance. However, when the pupils come from many states and countries and from all kinds of schools, and the individual teachers are unknown, then the results of diagnostic and intelligence tests seem the best guides in the initial placing of new boys.

Practically all the boys who come to Mount Hermon desire to take algebra. The problem then is to know at the start something of the ability of the group and to present the subject accordingly.

For three years a careful correlation has been made of the boys' I. Q. obtained from the Otis and Dearborn group intelligence tests and their standing at the end of the first semester in algebra. The results show that about 33% of the boys fail; that 65% of those with an I. Q. below 100 fail; that 40% of those with an I. Q. between 100 and 109 fail; that 34% of those with an I. Q. between 110 and 119 fail; that 20% of those with an I. Q. of 120 or above fail. The per cent of failures at the end of the second semester is about 20.

There are several reasons for the high mortality rate at the end of the first semester. The school is purely col-

lege preparatory. The course in first year algebra covers the work through quadratics in 36 weeks and through fractions in 18 weeks. The pace is fast, and therefore time for intensive drill is lacking. This procedure, however, quickly eliminates the slacker and brings out the good student. It also makes it possible early in the semester to recognize the plodder who does his work just through dogged persistence. Many boys coming from home life and public schools are slow to adjust themselves to the routine of a private boarding school. Others are slow to realize the importance of a careful preparation of each lesson. However, the I. Q. gives a fairly satisfactory basis for estimating a boy's probable chance of success. The results are quite in keeping with Thorndike's[1] conclusions that in general a pupil with an I. Q. less than 110 will be unable to understand the symbolism, generalizations, and proofs of algebra. With but few exceptions all the boys with an I. Q. of 110 or more who have failed have done so on account of lack of application, and not from any lack of ability. Now and then there is a notable exception.

There was one such case to which reference has already been made in the writer's class last fall,—a young man 20 years of age who had been out of school for about 3 years. His I. Q. was 123. His work in all subjects except algebra was satisfactory. In his grasp of algebra he never passed beyond the addition and subtraction of positive numbers. He seemed unable to grasp the idea of negative numbers and to the end of the semester he was never certain of the sum of $+14xy$ and $-7xy$, to say nothing of other operations. He seemed entirely devoid of number sense. He was just as uncertain in simple arithmetical operations. In the matter of vocabulary he was the best in the class. He had all of the definitions and rules of procedure letter perfect but had not the slightest conception of their meaning and use. The teacher gave him individual attention both in and out of class. For a time he studied his daily work with one of the best students in the class, but all to no avail. He just simply did not have any ability to do algebra.

Since one is reasonably sure that a boy with an I. Q. of 110 or above can do algebra if he wishes, and that a boy with an I. Q. between 100 and 109 has at least a 50-50

chance of mastering the subject even though the work is covered rapidly, the next questions to be considered are: When is algebra learned? How long does it take to master the necessary skills and abilities in order to do continuously satisfactory work? In other words, how long does it take the boy to learn the subject matter presented?

While carrying on this study with two colleagues[2] in an effort to throw some light on the above question, the writer turned to psychological and educational literature to find how the learning process is now defined. Dr. Bode[3] has a very good statement about the psychology of learning. He says: "Psychology at present is a scene of confusion and violent disagreement. There is a steadily mounting mass of data, but we do not know what they mean. When considered as a part of a teacher's professional equipment, psychology is of significance for the light that it sheds on the nature of the learning process. To the teacher it is all important whether the learning process centers in habit formation, or the cultivation of insight, or the untrammeled development of original tendencies. Unfortunately the choice among such alternative views cannot be decided by appeal to experiment. In the end it must rest on a theory of mind—this may be a hardship for the teacher, but it cannot be helped."

Dr. Bentley[4] refers to 4 common uses of the word "learning": "First, learning has been used to describe or to explain any abrupt modification in behavior. . . . Another common meaning of the word is the educational meaning, wherein the pupil is said to learn when he has acquired. . . . . A third definition extends it to all abilities and skills acquired by the individual on the basis of his native or instinctive endowment. A fourth employment of the word restricts it to the establishment of association."

Each of the above meanings of learning is directly dependent upon a distinct theory of the nature of the mind. If one attempts to master the various theories concerning the mind, he will have no time for the teaching of algebra. However, one quickly learns that there are at least 4 outstanding schools of thought centered about as many theories of the mind. Each school has many adherents, among whom there is little agreement. Each idea of learning has

its value, but to the ordinary class room teacher to learn means to acquire, to master, to make something a part of one's being at least for a limited period of time.

When the teacher stands before his class in beginning algebra for the first recitation, he is facing a matchless opportunity. The average pupil is eager to explore the mysteries of the subject. The teacher may take advantage of this attitude and conduct the journey of exploration that is full of interest to the end. The more he knows about psychology and the theories of learning, the better he can do his work, always provided he does not become a faddist. His one great thought should be so to conduct the class that the pupils will learn algebra and enjoy the process.

After this digression into the field of psychology it is well to return to the two questions: When is algebra learned, and how long does it take to do it? It is not the purpose of this study to analyze the various operations into their component skills and abilities. That has been admirably done by others.[5]

The purpose was to take certain operations as wholes, such as the use of the formula $A=\frac{1}{2}bh$, and to see how long it took the group to master as thoroughly as possible the operation and whether further drill led to group improvement.

The median I. Q. of the group studied was 108, which was considerably below that of the school as a whole. For the past 5 years the per cent of failures in beginning algebra at the end of the first semester has been 33. In consideration of these two facts it seemed as if an achievement quotient of 65 would be satisfactory. The achievement quotient (hereafter referred to as A. Q.) for any given operation in a given test is the per cent of those who answer the question correctly. That is, an A. Q. of 86 means that 86% of the 95 boys in the group performed the operation under consideration correctly in all steps, no partial credit being allowed toward an A. Q.

One operation will be carried through in some detail to show the method and results. The formula $A=\frac{1}{2}bh$ was developed and discussed during the third recitation of the term. On subsequent days some drill was given in its use. It first appeared on a quiz on the 9th day of the term. At

this time the values for b and h were given as integers, and the value of A was required. The A. Q. was 86. Five days later it again appeared on an unannounced quiz. This time the A. Q. was 75. The boys were also asked to solve the formula for b or h when the value of one and the value of A were given. For this the A. Q. dropped to 42. Whenever fractional values were given, much difficulty was experienced, and there was a decided drop in the A. Q. In all there were 9 A. Q.'s figured for the use of this formula during the term. The range was 33-86; the mean was 60. On the final examination for the semester the A. Q. was 69; on a quiz given the first recitation after two weeks' holiday vacation the A. Q. was 50.

Eleven operations were thus studied, and in all 81 A. Q.'s were calculated. In addition to this a special study was made of vocabulary mastery in which 66 A. Q.'s were calculated, making a total of 147.

The accompanying table gives a summary of the result. The graph shows the distribution of the 81 A. Q.'s. A study of the table shows that in no instance was there any decided trend toward improvement as the term advanced. The quizzes from which the A. Q.'s were figured were giv-

A TABLE OF ACHIEVEMENT QUOTIENTS.

Operations Considered	Number of A. Q's.	Range	Mean	First	Last
The formula $A=\frac{1}{2}bh$	9	33-86	60	86	69
The formula $P=2l+2w$	8	46-68	56	68	55
Fundamental operations with monomials	10	38-76	64	75	76
Fundamental operations with polynomials	10	34-81	68	78	71
Simple linear equations	8	67-96	80	96	94
Parentheses	5	56-91	66	58	64
Special products	5	59-77	66	59	77
Factoring	5	53-66	58	66	55
Verbal problems	11	33-81	59	51	51
Graphs	5	71-93	85	91	93
Miscellaneous	5	30-88	65	80	64
				mean	mean
Total	81	30-96	65	73	70
Vocabulary	66	24-95	65	52	77

Read table;—in the operations with the formula $A=\frac{1}{2}bh$; 9 A. Q.'s were figured, their range being 33-86, the mean of the 9 being 60, the first A. Q. being 86, and the last, 69.

en after the boys had had an opportunity to master the operation but not time for extended drill. In 6 of the 11 operations given in the table the first A. Q. figured was higher than the last. In only one instance, that of special products, was the last A. Q. materially greater than the first.

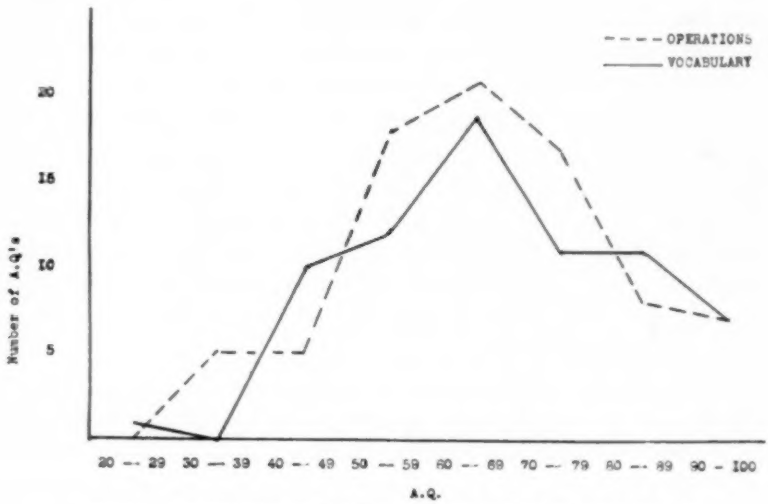


Diagram I: Distribution of 81 A.Q's for Operations and 71 for Vocabulary

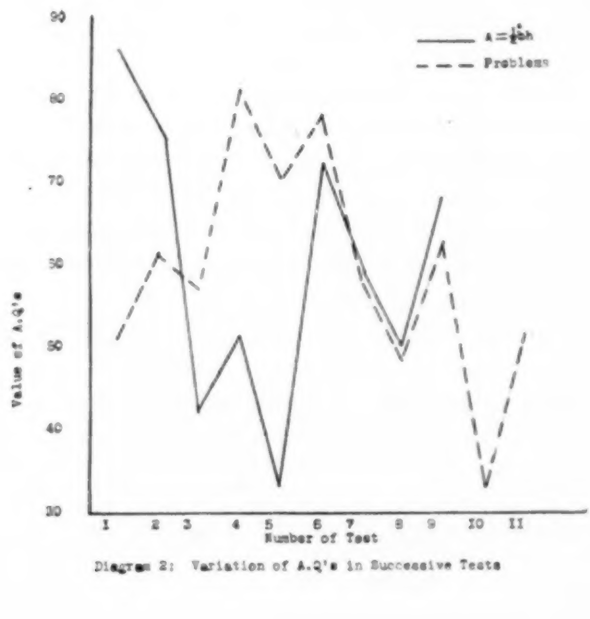


Diagram 2: Variation of A.Q's in Successive Tests

These facts would seem to indicate, at least in so far as this group of boys was concerned, that those boys who mastered any given operation when it was first developed had learned it in the sense of to acquire, while the others never really learned it; that frequent reviews of a given operation did not result in any marked group improvement but largely served to give those who knew it greater speed and facility in its use and application. To the writer these results were somewhat of a surprise.

One fact, however, must be kept in mind. The difficulty of the operation was increased as it occurred from time to time in review. In the case of verbal problems, the first A. Q. was 51, and the 11th and last, figured 14 weeks later, was also 51, but the last problem was much more difficult than the first. This shows that there was not much group improvement, and that in general those who correctly worked the first problem gained in power so that they were able to solve the last one.

It is usually the boy who can but does not that fails to improve. Of such boys Breslich[6] says, "Very little can be done for these students until they improve their habits of study." It would therefore seem that frequently recitation periods should be turned into study periods. For if now and then a boy can be taught to use his mind, even though the nature of mind is unknown, teaching will not have been in vain.

SUMMARY.

1. All boys are not able to learn algebra.

2. In general, a boy with an I. Q. of 110 can master the subject if he wishes.

3. The theories concerning the nature of the mind and the learning process are such that no one can say definitely how the boy learns his algebra.

4 The present study seems to indicate that those boys who grasp a topic when it is first developed learn it; that further drill results not in group improvement but in increased power to the individual who first learned the operation.

REFERENCES.

1. Pages 36 and 37 in *Psychology of Algebra*, E. L. Thorndike, Macmillan Co., 1922.

2. Leonard W. Ellinwood and Howard R. Fuller, masters at Mount Hermon.

3. Page 3 of the *Preface, Conflicting Psychologies of Learning*, Boyd Henry Bode, D. C. Heath Co., 1929.

4. Pages 330, 331 in *The Field of Psychology*, Madison Bentley, D. Appleton Co., 1928.

5. *Psychology of Algebra*, E. L. Thorndike.

6. Page 96 in *Teaching of Mathematics in Secondary Schools*, Ernst R. Breslich, U. of Chicago Press, 1930.

A SPECIAL METHOD IN MENSURATIONAL GEOMETRY.

BY SISTER MARY GERARD,

Graduate Student, University of Illinois.

In the field of mathematics there are engaged teachers, conscious of the fact that better methods of teaching are both possible and desirable, seeking those devices and methods which were of assistance to others in bringing about an improvement in their work. The purpose of this article is to submit for their consideration a plan of procedure which was found especially helpful in the teaching of mensurational geometry to junior high school students. The frequency of the use of the method depends upon the ability levels of the pupils. If the individual differences are very great its frequent use is commended.

The aim of the plan was to afford to the students an opportunity for the practical application of knowledge. It was not based on any one method of instruction but took from the several those ideas most conducive to its accomplishment. The pupils who received this type of instruction were members of an average class in junior high school mathematics who were studying mensurational geometry. When they assembled for their class period they were directed to bring to class the next day a quantity of prepared molding clay, protractors and straight edges.

At the next meeting of the class the students were presented with mimeographed instructions for their procedure. These were as follows:

"*Given:* A quantity of molding clay, protractor and straight edge.
"*Required:* To mold and find the total area of a prism whose bases are squares."

At this point the preparation of the students was determined by their answers to questions of these kinds—What is a prism? How do you find its area? If the bases were rhombi instead of squares would you use the same method?—After this exploration the remainder of the instructions were read.

"Without changing the amount of clay mold a prism whose bases are rhombi and find its total area.

"Tabulate and compare the results of your findings for the two models."

The students were very eager to test their new ability. Their wants had been provided for and there was little need to give any individual any particular attention while he was at work. The desire for efficiency held each to his task.

One of the students obtained the following results which he tabulated as below:

Prism with Square Base	Prism with Rhombus Base
1. Side and square 10 cm.	1. Side of rhombus 10 cm.
2. Perimeter 40 cm.	2. Perimeter 40 cm.
3. Altitude 12 cm.	3. Altitude 12 cm.
4. Area of each base 100 sq. cm.	4. Area of each base 96 cm.
5. Total base area 200 sq. cm.	5. Total base area 192 cm.
6. Lateral area 480 sq. cm.	6. Lateral area 480 sq. cm.
7. Total area 680 sq. cm.	7. Shorter diagonal 12 cm.
	8. Longer diagonal 16 cm.
	9. Total area 672 sq. cm.

The total area of the rhombus base prism was 8 sq. cm. less than the total area of the square prism base.

Similar results were obtained by the other pupils, who for the most part were surprised to discover that the amount of surface had changed although the quantity of clay remained the same. Their attention had been called to the difference in the total areas of two such figures but they were not impressed until they saw a demonstration of the fact. It was then that their complacency of thought was disturbed. This was a most desirable effect for it tended to bring about a certain distrust of things which are apparent but not proved.

The discussion which followed the experiment offered many suggestions for further study of the surfaces of solids.

This method of class instruction held the attention of each pupil to his own task and all were kept at nearly the same level of attainment.

The satisfaction of the slower pupils in the realization that they had achieved a success comparable to that of the more gifted ones stimulated them to greater effort in their daily work, for the desire for efficiency is one of the strongest impulses of children and no activity affords a child keener interest or greater satisfaction than that which gives him conscious skill.

A CHEMISTRY CLUB BANQUET.

BY JOHN J. CONDON,
Nottingham High School, Syracuse, New York.

It has been the practice in our Chemistry Classes to have a small party at some time during the year, generally at the time of a class club meeting and usually as part of some students' demonstration. The present group were asking among themselves just when they would have their affair. Two of the more inquisitive, let us say, popped the question and were made members of the committee together with two students preparing to major in domestic science.

The committee wanted something bigger this year in the form of a banquet. The Chemistry laboratory was suggested as the proper place for a Chemistry Club Banquet.

At the first meeting of the committee a menu was decided upon. An optional form was also chosen should the first menu prove too difficult to apply in the laboratory. The plan of invitation, entertainment and all specialized work for each member of the committee was assigned at this meeting. Two other committee meetings were held one of which was for the actual timing and trying out of the plan of cooking in the ordinary desk glass ware. The temperatures necessary, portions more easily used, sequence of parts in preparation were very carefully worked until all items might be prepared within a forty minute period.

The principal and his assistant as well as the members of the class were given invitations in the form of "detention slips" signed by the committee, telling them they were to report in the Chemistry Laboratory to attend the Chemists' Banquet a week from that date.

The Alchemists of old shrouded their projects in no more mystery than did this group protect this experiment. Surprise is not the word to explain the reaction of the assembly. Each of the following incidents served to increase the enthusiasm as everyone moved in the spirit of the unusual arrangements.

Each found his place card (labels) attached to his menu printed on circular four inch filter paper as follows:

Chemistry Club Banquet

Object:	To Enjoy Yourselves Preparing and Eating a True Chemists' Dinner.
Apparatus:	Supplied From Your Own Desk Set.
Materials:	Furnished to you "in the raw."
Procedure:	Under Direction—to prepare your dinner, as follows:
	Fruit Evaporating Dish.
	Stew via the Beaker.
	Olives and Celery on Watchglass.
	Hot Rolls Direct from Drying Oven.
	Coffee a la Funnel.
	Rice Pudding en Beaker.
	Crystalized Ice Cream with Cakes.
	Mints and Nuts.

Dorothy Brown—Hostess Norbert Richer—Chairman.

All were instructed to get their aprons and to put them on with dispatch. (It was a pity to cover the nice dresses and newly pressed suits.) Bunsen burners, stands, beakers, and spatulas were next assembled for each person. The "Hostess of the Banquet" directed all in the preparations even to suggesting the amounts to be used and the degree of heat to apply.

That time might be saved the committee had prepared the meat and vegetables (cut in small pieces) for the stew, cooked rice for the pudding, cut the fruit for the cocktail, and supervised the preparations of the individual dinners. One of the committee heated the rolls in the drying oven.

The first preparation was the stew. Each selected the ingredients from the several dishes and put them into his beaker. This was now placed over the Bunsen burner. The next several minutes were spent in getting the contents to the point at which it would cook well with little attention.

Water was put on to boil in a liter beaker. One of these was located at each of the tables which would accommodate four students. Another student at this point brought a pan of water to a boil in which the four rice puddings were to be cooked. Smaller beakers were filled with the material which would be the dessert, when cooked in the pans of hot water.

When these parts were cooked to a definite point the original "drip" method of making coffee was applied. A large six inch funnel was lined with filter paper and the boiling water was poured over the grounds on the filter paper. The filtrate was collected in quarter liter flasks.

Evaporating dishes were next called for and in these each received fruit cocktail from the battery jars and the party was on. Olives and celery were served in the watch glasses as was the butter. Small beakers contained the cream and sugar. Salt was dispensed from the original one pound containers.

The stew was now ready and our friends who had expected a service banquet found instead that their camping experience together with their Chemistry technique was serving them well. Chef de pudding has pronounced his task complete. Spatules are again brought into use. This was followed by some group singing. The committee served the ice cream and cake. A few short talks by the guests and the several members of the class completed our first—all Chemist Banquet.

As it is the proper procedure to clean up all apparatus after each experiment that plan was followed. Mints and nuts served at this time helped to make the work lighter and more pleasant.

This was the longest club meeting of the year, taking the full two hours to complete the banquet. The next meeting centered around a suggested plan of having such an affair each year. That those here present at the meeting might again attend a similar dinner it was the plan to make this yearly affair to include the alumni. It was so voted.

MOTOR CAR IS CREATION OF LIGHT.

The motor car is a creation of light. Not that blazing lamps or the sun's rays will alone turn out a sport model, but as few people realize, automobile production requires the ultimate in practical illumination.

All the way from foundry to the point of finished bodies, light of particular intensity and character plays a vital part. In one of the principal auto manufacturing companies, a report in the Electrical World tells, light intensities varying from 8 to 140 foot-candles are employed. Lights of 20 foot-candle power are used most on the average.

Normal daylight, because of its variability, is not sufficient. To supplement it, about 3000 mercury-vapor lamps lend their light in the manufacturing company surveyed, and 25,000 ordinary incandescent lamps. Both types together illuminate the entire area of the plant, three million and a quarter square feet. Even the finished product demands plenty of light, as a nocturnal inspection of any fashionable display room will prove.

A PARALLEL-PLATE INTERFEROMETER.

By R. WILLIAM SHAW,

Department of Physics, Cornell University.

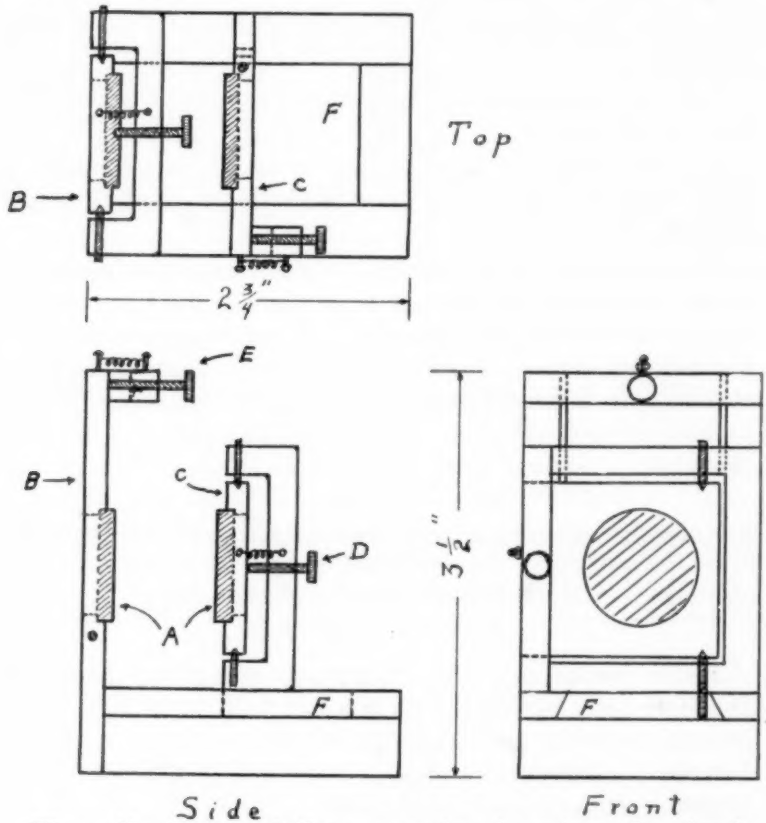
The study of interference of light always presents an interesting problem to students of physics. Perhaps this interest may be due, at least in part, to some of the things which have been accomplished by means of interferometers. Among these one calls to mind the efforts of experimenters to detect an ether-drift, the determination of the length of the standard meter in terms of the wave-lengths of light, the accurate determination of wave-lengths of light, and the study of the fine structure of spectral lines.

Many of the classic experiments of interference may be performed by means of the Michelson interferometer. Not all laboratories, especially high school laboratories, are fortunate enough to possess a Michelson interferometer. Also in many instances the adjustment and manipulation of this instrument is rather difficult for the beginner.

The writer has designed a small parallel-plate interferometer (Fabry and Perot) which has proved to be especially easy of adjustment, very stable, and versatile in application. The figure shows three views of the instrument. Two plane-parallel plates of glass A, which are one inch in diameter and half-silvered on the inner sides, are held by means of wax in countersunk holes in the brass plates B and C. Plate C is arranged so that it may be rotated about a vertical axis. The pivots about which rotation is possible are conical steel screws shown in the figure. A set screw D and a coil spring directly above D maintain the plate C at any desired place. Plate B may be moved only about a horizontal axis. The motion and position of this plate are controlled by the screw and spring E. It follows that the plates B and C, which carry the glasses A, may be made quite parallel to each other since rotation takes place about axes mutually at right angles.

The frame holding plate B is fastened rigidly to the base of the instrument, and the plate C is arranged on a beveled base F which is held in place by the guides shown in the figure. With this arrangement it is possible to move plate C as near to B as is desired. In the actual instrument screws were provided for varying the distance of C from

B. These screws have been omitted from the drawing for the sake of clarity. They are not accurately cut screws since the plates have a fixed distance apart during any one experiment.



The adjustment of the apparatus is extremely simple. If the instrument is held in front of a sodium flame so that light may pass through both glass plates, a number of images of the flame will be seen. These images are due to successive reflections of the light from the silvered surfaces. By adjusting the screws D and E (the distance between the plates should be small) the series of images may be made to exactly coincide. Interference fringes will then be seen. The character of the fringes may be varied by further slight adjustments.

This instrument has been used successfully for the following experiments:

1. The calibration of spectrometers by interference fringes both in the visible and infra-red regions.

2. The tracing of Michelson's visibility envelop for the yellow lines of the mercury arc.

3. The photography of circular fringes of the mercury spectrum.

4. The resolution of the yellow doublet of sodium by circular fringes.

5. The determination of the ratio of wave-lengths of close spectral lines. This illustrates the method of attack on hyper-fine structure.

The adjustments of this instrument are so simple and easily made that the student may make a detailed study of the conditions for the production of various types of interference patterns without loss of time. Furthermore the stability of the instrument is very good and consequently it does not get out of adjustment at the slightest provocation.

A UNIQUE MODIFICATION OF HELMHOLTZ'S SIREN EXPERIMENT.

By Frank Van de Water,*

K. S. C., Hays, Kan.

While performing the experiment commonly known as the Helmholtz Siren,[1] the writer met with some difficulty in identifying with positive certainty the points of resonance for the fundamental and lower overtones of the tube employed. This difficulty prevailed in spite of the fact that he is more or less of a musician and, consequently, should be able to detect these points with greater ease than one uninformed in music. It was possible, however, to select at random various points of probable resonance discarding those values which the theory did not demand. Since this procedure involves a certain amount of approximation or guesswork, the author cast about for a more exact means of determining the exact points of resonance.

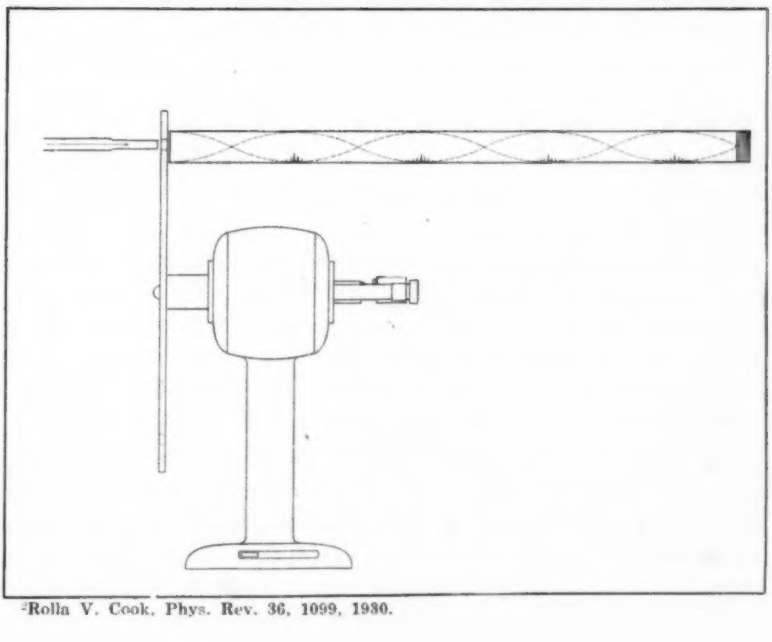
With this idea in mind, certain elements of the Kundt's tube experiment were incorporated into the Siren experi-

*Communicated by Prof. Harvey A. Zinszer.

[1]Taylor-Watson-Howe: General Physics for the Laboratory, Experiment XXXIX. (Ginn & Co.)

ment. The glass resonating tube was supported horizontally, corked at the far end and sprayed inside with cork dust. The work was then carried on as before using a disk with five circular rows of holes containing 24, 24, 30, 36 and 48 holes, respectively. The disk was driven by a variable speed Bodine 110 a. c.-d. c. motor with speed counter attachment. For air, we merely attached a rubber hose with a finely tapered glass nozzle to the compressed air line. The results were exceedingly gratifying, for by this procedure the points of resonance could not be mistaken, the loops or ventral segments being clearly outlined by striae of cork dust.

Obviously, the experimental values of frequency compared very favorably with those demanded by the law of resonating pipes closed at one end. The law for open pipes could not be verified by this method because the force of the air pressure tended to blow the cork dust out of the tube. Incidentally, this is the first time within the writer's knowledge that these two famous experiments have been combined in exactly this fashion, except for one instance in which Professor Cook[2] of Bethany College used the method for studying the formation and mechanism of striae. A figure illustrates the arrangement of apparatus.

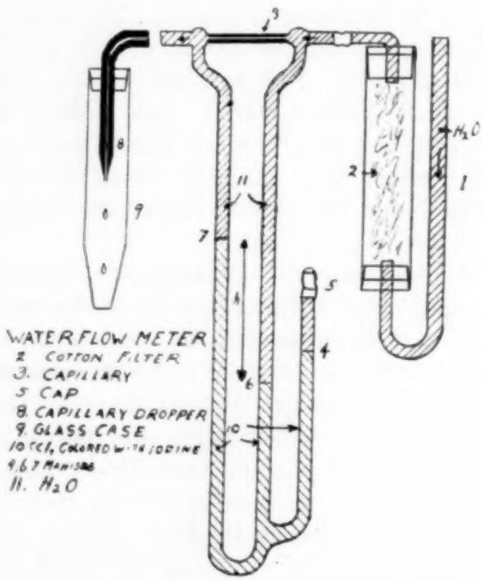


[2]Rolla V. Cook, Phys. Rev. 36, 1099, 1930.

A FLOWMETER FOR MEASURING SMALL AMOUNTS OF WATER FLOW.

By L. E. McAllister,
Professor of Physics, Shorter College, Rome, Ga.

This water flowmeter is of the same design as the ordinary flowmeter for measuring the flow of gases. That is, a manometer is placed across a capillary tube to indicate the rate of flow after having been calibrated against a standard meter. The water to be measured flows through the capillary in place of gas. The indicating differential is formed by the liquid maniscus between the water and a heavier colored liquid immiscible with water. This particular flowmeter was designed to measure a flow of about 3 c.c. of water per minute.



The water passes from a needle valve on the main water line through tube No. 1 (see figure) and up through a larger tube No. 2 which contains absorbent cotton to remove all traces of dust or rust from the water. It then flows through the capillary and through a dropper so drops may be counted occasionally as a check. Of course mercury may be used as the heavier liquid, but the capillary has to be too small if a large differential is desired. The liquid used in this case is carbon-tetrachloride colored with iodine. It is a bright color and a good maniscus is made with water. The specific gravity of carbon-tetrachloride is 1.58, hence the resistance of the flowmeter with a 4 inch differential is equivalent to 2.3 cm. of water pressure as compared with over 50 cm. if mercury were used.

PROBLEM DEPARTMENT.

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution, or proposed problem, sent to the Editor, should have the author's name introducing the problem or solution *as on the following pages.*

The Editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SPECIAL NOTICE.

Please observe that the Editorship of the problem department has changed. All communications relating to this department should go to the new Editor.

LATE SOLUTIONS.

1173. *Albert Whiteman.*

SOLUTIONS OF PROBLEMS.

Editor.—Persons sending in solutions should read carefully the instructions about the form of the solutions and the ink-drawn figures. Many times, a good solution is received, but poorly arranged and no India-ink figure given.

SOLUTIONS OF PROBLEMS.

1175. *Proposed by E. B. Escott, Oak Park, Ill.*

In the binomial expansion $(x+1)^2=x^2+2x+1$, I notice that there are three coefficients in arithmetical progression, that is, 2, 1, 0. Are there any other binomial expansions where three consecutive coefficients are in arithmetical progression?

Solution by Proposer: Three consecutive binomial coefficients may be denoted by

$$n(n-1)\ \ldots\ (n-r+1)/r!,\ n(n-1)\ \ldots\ (n-r)/(r+1)!,$$
$$n(n-1)\ \ldots\ (n-r-1)/(r+2)!$$

If these are in arithmetical progression, they will still be in A. P. if divided by the same number. Dividing by

$$n(n-1)\ldots(n-r+1)/(r+2)!$$

we have for the condition that the three numbers

$$(r+1)\,(r+2),\qquad (r+2)\,(n-r),\qquad (n-r)\,(n-r-1)$$

must be in A. P. Then twice the middle term must equal the sum of the first and third terms. Simplifying this equation, we have

$$4r^2-(4n-8)r+n^2-5n+2=0$$

i. e.,

$$[2r-(n-2)]^2=n+2$$

This has integral solutions if $n+2$ is a square.

Examples:

$n=2$	$r=1$	2, 1, 0
$n=7$	$r=1, 4$	7, 21, 35
$n=14$	$r=4, 8$	1001, 2002, 3003
$n=23$	$r=8, 13$	490314, 817190, 1144066

....

The number of solutions is infinite.

Also *solved by Albert Schwartz, Perth Amboy, N. J., Everett E. Cook, Philadelphia, Miss., and W. E. Buker, Leetsdale, Pa.*

1176. *Proposed by B. M. Lindemuth, Defiance, Ohio.*

In attempting to cross a stream at right angles to the current, a man finds that the best he can do is to land 3 miles down stream from a point directly opposite starting point. If the width of the stream is 4 miles and the rate of the current is 5 miles per hour, how fast can he row in still water?

Solution by Guy C. Lentini, Boston, Mass.

The velocity of the boat in the direction of the stream is 5 mi. per hour and since, when he lands, he has traveled 3 miles (in direction of stream), $\frac{3}{5}$ hours have been consumed. But in a direction across the stream he has traveled 4 miles, therefore his velocity in that direction will be $4/.6 = 6\frac{2}{3}$ miles per hour. This is the velocity that the boatman can acquire in still water since in this direction the river does not aid him.

Also *solved by W. E. Batzler, Battle Creek, Mich., S. Bamberger, Harrisburg, Pa., Central High Mathematics Club, Cape Girardeau, Mo., M. Freed, Wilmington, Calif., Wayne French, Shaker Heights, Ohio, and W. E. Buker, Leetsdale, Pa.*

One incorrect solution was offered.

1177. *Proposed by Albert Whitman, Philadelphia, Pa.*

Find a number N so that the sum of the digits of its square gives x^2, and the sum of the digits of its cube gives x^3.

Solution: *By W. E. Buker, Box 66, Leetsdale, Pa.*

The conditions of the problem are fulfilled if N is any of the following numbers: 1, 2, 10, 11, 20, 39, 101, 105, 110, 111, etc.

Any number of the form 1×10^r, or 2×10^r is also a solution; also 10^r+1.

This does not give a general method for finding N.

Also *partially solved by Everett E. Cook, Philadelphia, Miss.,* and *S. Bamberger, Harrisburg, Pa.*

1178. *Proposed by H. R. Scheufler, Culver, Indiana.*

Inscribe an equilateral triangle within an angle with one vertex at a given point within the angle.

Solution by the Proposer.

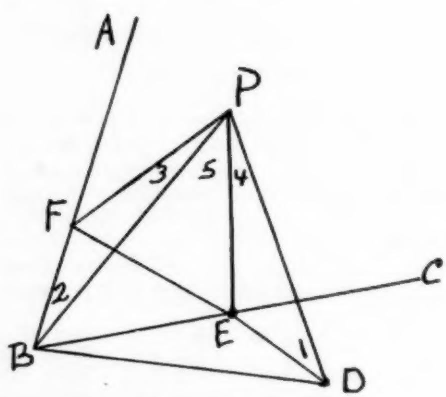
Given $\angle$ABC and point P.

Required to inscribe an equilateral triangle in $\angle$ABC.

Construction:

Draw BP and then construct an equilateral BPD. Construct $\angle 1 = \angle 2$.

Draw PE; lay off BF = ED; draw PF and FE. Then PFE is the required triangle.



Proof

$\triangle BFP \cong \triangle EDP$

$PF = PE$

$\angle 3 = \angle 4$

$\therefore \angle 3 + \angle 5 = \angle 4 + \angle 5 = 60°$

$\therefore \triangle PFE$ is equilateral.

Note: The solution of this problem appears in Altshiller-Court's College Geometry, page 46.

Also *solved by W. E. Buker, Leetsdale, Pa., M. Freed, Williamington, Calif., and A. Struyk, Paterson, N. J.*

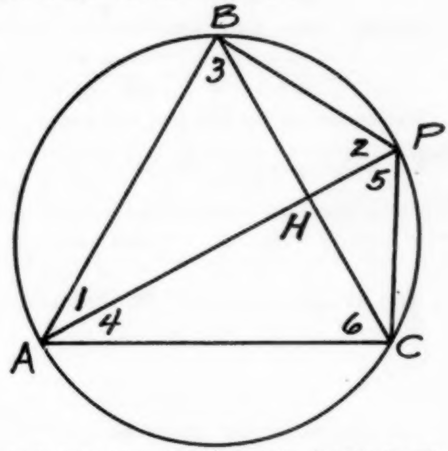
1179. *Proposed by R. T. McGregor, Elk Grove, Calif.*

Prove: If the vertices of an equilateral triangle inscribed in a circle are joined to any point on the circumference, one join equals the sum of the other two joins.

Solved by A. Struyk, Paterson, N. J.

Ptolemy's Theorem gives an immediate solution of this problem, but the following proof is more elementary.

AB = BC = CA, and therefore arc AB = arc BC = arc CA.



In triangles ABP and ABH, $\angle 1$ is common, and $\angle 2 = \angle 3$ since arc AB = arc CA.

In triangles ACP and ACH, $\angle 4$ is common, and $\angle 5 = \angle 6$ since arc CA = arc AB.

Hence, $\triangle ABP \sim \triangle ABH$, and $\triangle ACP \sim \triangle ACH$.

Therefore AP : AB = BP : BH; AP : AC = CP : CH.

From these proportions,

$$AP \cdot BH = BP \cdot AB$$
$$AP \cdot CH = CP \cdot AC.$$

Adding $AP(BH+CH) = BP \cdot AB + CP \cdot AC$.

But $BH + CH = BC = CA = AB$.

Therefore $AP = BP + CP$.

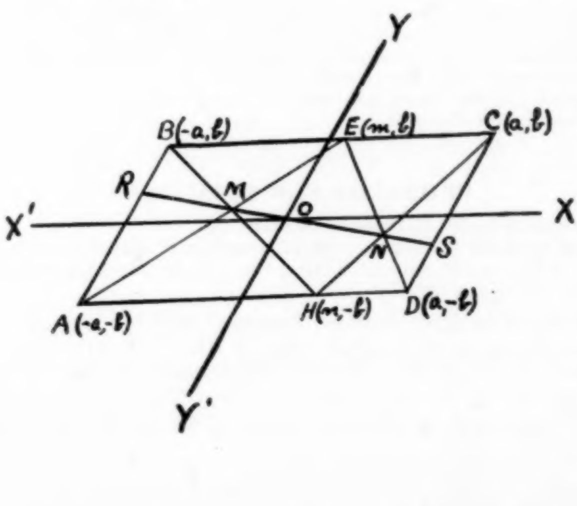
Also *solved by W. E. Buker, Leetsdale, Pa., W. E. Batzler, Battle Creek, Mich., Wayne L. French, Shaker Heights, Ohio,* and *Mack Tucker, Bremen, Ind.*

1180. *Proposed by A. Struyk, Paterson, N. J.*

ABCD is a parallelogram. E is any point on BC; H is any point on AD. AE, BH intersect at M; DE, CH intersect at N. The line through M and N meets AB at R, and CD at S. Prove AR = CS.

First solution by B. M. Lindemuth, Defiance, Ohio.

Through O, the center of the parallelogram, draw axes XX′ and YY′ parallel to the sides. Let the co-ordinates of the points A, B, C, D, E and H be indicated in the figure.



Using the formula:

$$\frac{y-y'}{y'-y''}=\frac{x-x'}{x'-x''}$$

to write the equation of a line when we have the co-ordinates of two points given we get the following equations:

For AE, $\frac{y-b}{2b}=\frac{x-m}{m+n}$, for BH, $\frac{y-b}{2b}=-\frac{x+a}{a+n}$.

Solving these two simultaneous equations in x and y we get,

$$x=\frac{mn-a^2}{m+n+2a},\ y=\frac{b(n-m)}{m+n+2a},$$ as the co-ordinates of M.

The equations for ED and CH are:

For ED, $\frac{y-b}{2b}=\frac{x-m}{m-a}$, for CH, $\frac{y-b}{2b}=\frac{x-a}{a-n}$.

These equations when solved simultaneously give,

$$x=\frac{mn-a^2}{m+n-2a},\ y=\frac{b(n-m)}{m+n-2a},$$ as the co-ordinates of N.

Now writing the equation for the line through MN, we get:

$$\frac{y-\dfrac{b(n-m)}{m+n+2a}}{\dfrac{b(n-m)}{m+n+2a}-\dfrac{b(n-m)}{m+n-2a}}=\frac{x-\dfrac{mn-a^2}{m+n+2a}}{\dfrac{mn-a^2}{m+n+2a}-\dfrac{mn-a^2}{m+n-2a}},$$

which when simplified becomes $(mn-a^2)y=b(n-m)x$. Since in this equation $x=0$ when $y=0$, MN (or RS) must pass through O, which is the mid-point of the diagonals. Now if we draw the diagonal AOC and compare triangles AOR and COS, we have AO = OC, angle AOR = angle COS, and angle OAR = angle OCS. Therefore the triangles are congruent and AR = CS.

Second solution by W. E. Batzler, Battle Creek, Mich.

Given: Parallelogram ABCD and E, H any two points on BC, AD.
To prove: AR = CS.

1. Draw the diagonals AC and BD intersecting at O.
2. Then ACHBDE is a degenerate form of hexagon inscribed in the conic section BC, AD (the || lines BC and AD are the section of a cone having its vertex at infinity by a plane || to the axis of the cone).
3. ∴M, O and N which are the points of intersection of the opposite sides of this hexagon are collinear. (This is because of Pascol's theorem which says that the points of intersection of the opposite sides of a hexagon inscribed in a conic are collinear.)
4. ∴ROA ≅ △SOC and AR = SC.

Also solved by the Proposer.

PROBLEMS FOR SOLUTION.

1193. *Proposed by W. E. Buker, Leetsdale, Pa.*

Required to draw an n-gon with all possible diagonals. If a stroke is defined as a line made without lifting the pen or retracing any line, how many strokes are required?

1194. *Proposed by Morris Savage, Paterson, N. J.*

AB and CD are both perpendicular to BD, with AD = 100, BC = 80. If they meet at P with PM = 10 and perpendicular to BD, find length of BD.

1195. *Proposed by E. C. Kennedy, College of Mines, El Paso, Texas.*

$\frac{(n+2)+(-1)^n(n-2)}{4}$, $(n=3, 4, 5, \cdots)$.

In a right triangle CAB, AC = 3956 miles, AB = 50 miles. With C as a center, a circle is drawn through A tangent to AB and cutting the hypotenuse BC at D. Find the length of arc AD to within an error of 1/10 of an inch, using a five place table to obtain angle C. (See Kennedy's Manual of Trigonometry, Prob. No. 100.)

1196. *Proposed by Guy C. Lentini, Boston, Mass.*

The following problem came up in the course of solution of an analytic geometry problem:

Proposed problem:

Given: $mn = pq,\qquad m+p = n+q$

show that $m = q,\ n = p.$

1197. *Proposed by Harry Frye, Tullahoma, Tenn.*

Just before a rainfall a right circular conical flower cup ten inches in height with a five-inch mouth was stuck into the ground with the axis of the cone at an angle of sixty degrees with the level of the ground. The point of the cone reached into the ground to a vertical depth of three inches. After the rain the surface of the water in the cone was at ground level. How many inches of rain fall? Trigonometric solution desired.

1198. *Proposed by Peter Drohan, Toronto, Ont.*

One hundred feet of flat tape 1/10 of an inch thick is rolled into a coil. Find the diameter of coil.

SCIENCE QUESTIONS

A Column of Co-operation in a Magazine of Co-operation. Conducted by Franklin T. Jones, 10109 Wilbur Avenue, Cleveland, Ohio.

Co-operation is the **process** of **Give and Take.** What can you give? What would you like to take? Please help to make this a real **Department of Co-operation.**

WHAT'S INTERESTING IN SCIENCE ANYWAY!

HOW FAST?

584. *Major Doolittle takes a Little Jaunt.*

As I write this (September 4, 1931), the radio says that Major Doolittle started this morning for Los Angeles, reached the National Air Races at Cleveland in the afternoon for a late lunch (winning the long end of a $15,000 prize), and went on to New Jersey (winning an additional $2,500). He has just returned to Cleveland for supper with Mrs. Doolittle and Jimmie, Jr., but must set out for St. Louis where he has an engagement tomorrow morning. He broke the records. How fast did he go?

Answer from "Western Flying," October, 1901, p. 18.

"Trans-continental Free-for-All for Bendix Trophy, J. H. Doolittle, St. Louis, Mo., Laird Plane—Wasp. Jr. Engine, speed 223.038 m. p. h."

INERTIA AGAIN.

585. Packard wants someone to definie "inertia" (and "momentum," "energy," etc.).

By the way, what had the "inertia" of the air to do with Doolittle's flight, or the flight of any plane?

A FLOATING LINER.

586. The *Berengaria* "floats" in water, displacing say 10,000 tons What is its weight?

The *Akron* "floats" in air. (Does it?) What is its weight?
Here in Cleveland at intervals we see the air liner "floating" over us.
Is ordinary flotation operating the same way in both instances?

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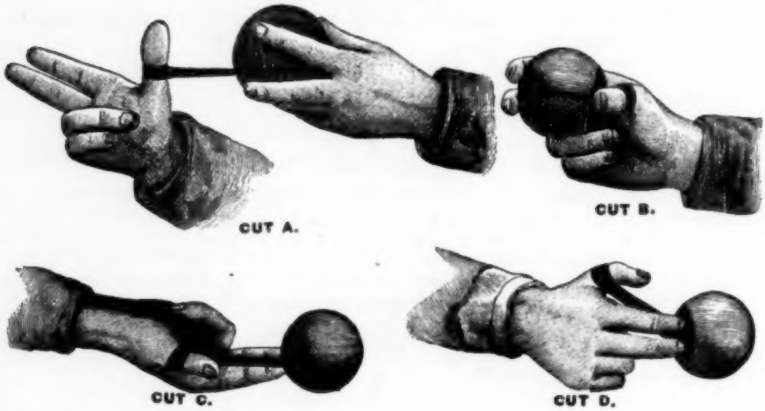
587. BASE BALL CURVER.
(*Patent applied for.*)



A pitcher curves the ball by imparting to it a rotary motion as it leaves his hand. The Base Ball Curver, by giving the ball a greater rotation than can be given it by the hand, produces a greater curve. To illustrate this rotary motion or twist: Put the loop of Curver on the thumb of right hand, place the ball in the hollow part; now hold the ball as shown in Cut A, stretching the rubber sufficiently to go around the ball and lap about two inches. Cut B shows the Curver thus lapped, and also the proper position of holding the ball before throwing. While holding the ball in this position (Cut B), open the hand suddenly and the ball will rotate or twist quickly. The whole art of curving the ball lies in this movement of opening the hand suddenly, all at once, thus allowing the ball to rotate freely as it is leaving the hand. The ball curves in the direction in which it rotates. Thus, for the in-curve, the Curver draws on the right side of the ball; while for the out-curve, the hand being reversed, causes the Curver to draw on the left side producing a curve in that direction. To pitch an out-curve, hold the ball as shown in Cut B; in delivering the ball throw the arm forward midway between the shoulder and waist, and at the moment of releasing the ball turn or twist the hand quickly to the left, allowing the ball to leave the hand as shown in Cut C. To pitch an in-curve, hold the ball as shown in Cut B, throw the ball at a height equal to the shoulder, allowing it to leave the hand as shown in Cut D.

J. H. BURNS, 99 Carroll Street, Cleveland, Ohio.

The above was found among some of the papers of Mr. J. H. Burns, a baseball fan *preceding 1890*. The cuts and description were prepared to market "Burns Base-Ball Curver."

You can curve a ping-pong (or any light) ball by wrapping a stretched rubber band around it and using the band to "pitch" the ball. Try it.

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588. FLYING CADETS OF THE AIR CORPS.

Aviation as a Career is the title of a booklet prepared under the direction of the Adjutant General of the Army, Washington, D. C. Examinations are given in United States History, General History, English Grammar and Composition, Geography, Arithmetic, Algebra, Higher; Geometry, Plane and Solid; Trigonometry, Plane and Spherical; Elementary Physics.

Examination for Flying Cadets.

Physics

Answer any ten (10) of the following questions. Each question has a weight of ten (10) points:

1. A uniform bar 10 feet long has a load of 45 pounds suspended from one end and balances when a support is placed 2 feet from that end. What is the weight of the bar? (The C. G. of the bar is in the middle.)
2. Two boys, A and B, are carrying a 100-pound load strung on a pole between them. Their hands are 10 feet apart and the load is 3 feet from A. How much does each carry? Neglect the weight of the pole.
3. An automobile is moving at the rate of 10 miles an hour when the driver presses the accelerator, thus giving the car an acceleration of 3 feet per second. How many miles an hour will the car be moving at the end of 5 seconds?
4. The net lift of a captive balloon is 250 pounds and it is held by an anchor rope which makes an angle of 60° with the ground. Compute the tension in the anchor rope (assumed to be straight) and the horizontal force exerted by the wind against the balloon.
5. (a) If the voltage of a trolley system is 550 volts what current will flow through a car heater whose resistance is about 100 ohms?
   (b) An electric heater of 30 ohms resistance can safely carry 4 amperes. How high can the voltage run?
6. State two of Newton's Laws of Motion.
7. State Boyle's Law or Charles' Law.
8. State Ohm's Law.
9. What current will flow through an external resistance of 14.64 ohms connected to three cells in series, each cell having a voltage of 1.5 volts and an internal resistance of .12 ohm.
10. What is the amperage in each cell of a battery of four cells arranged in parallel? The voltage of each cell is 1.5 volts, the internal resistance equal to .12 ohm and the external resistance of .17 ohm.
11. The speed attained by a body which slides without friction down an inclined plane is the same as the speed which the body would attain had it fallen the vertical distance from point of starting. PROVE.

AN IMPORTANT QUESTION.

What is the most important nut on an automobile?

BOOKS RECEIVED.

Principles and Practice of Hygiene, A Textbook for College Students by John Richard Cain, Assistant Professor of Hygiene, Medical Adviser for Men, University of Illinois, Urbana, Ill. Cloth. Pages xiv+251. 58 Illustrations. 14.5x22 cm. 1931. P. Blakiston's Son and Co., Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $1.75.

Mammalian Anatomy, with Special Reference to the Cat by Alvin Davison, Ex-Fellow of Princeton University; Professor of Biology in Lafayette College. Fifth Edition, revised by Frank A. Stromsten, Associate Professor of Animal Biology, State University of Iowa. Cloth. Pages xiv+311. 141 Illustrations. 14x21 cm. 1931. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pennsylvania. Price $2.50.

The Story of Science by David Dietz, Fellow of the Royal Astronomical Society; Member of the American Astronomical Society and the Societe Astronomique de France; Lecturer in General Science, Western Reserve University; Member, Ohio Academy of Science. Cloth. Illustrated. Pages xvii+387. 14.5x22 cm. 1931. Sears Publishing Company, Inc., 114 East 32nd Street, New York. Price $3.50.

The Science of Human Living by Walling Corwin, San Diego Senior High School and Mae Johnson Corwin, Phineas Banning High School, Los Angeles, California. 7th Grade. Cloth. Pages xii+464. 12.5x19 cm. 1931. Harr Wagner Publishing Company, 609 Mission Street, San Francisco, California. Price $1.68.

The Science of Plant and Animal Life by Mae Johnson Corwin, Phineas Banning High School and Walling Corwin, San Diego Senior High School. 8th Grade. Cloth. Pages xv+592. 12.5x19 cm. 1931. Harr Wagner Publishing Company, 609 Mission Street, San Francisco, California. Price $1.72.

The Science of Discovery and Invention by Walling Corwin, San Diego Senior High School and Mae Johnson Corwin, Phineas Banning High School, Los Angeles, California. 9th Grade. Cloth. Pages xix+735. 1931. Harr Wagner Publishing Company, 609 Mission Street, San Francisco, California. Price $1.80.

Useful Science by Henry T. Weed, Head of the Science Department Girls Commercial High School, Brooklyn, New York and Frank A. Rexford, Director of Civics, City of New York. Book One. Cloth. Pages xvi+222. 12.5x19 cm. 1931. The John C. Winston Company, 1006-1016 Arch Street, Philadelphia, Pa. Price $1.08.

Craftsmanship in the Teaching of Elementary Mathematics by F. W. Westaway, Author of "Scientific Method, its Philosophical Basis and its Modes of Application," "Science Teaching: What it Was—What it Is—What it Might Be," "Geometry for Preparatory Schools," etc. Cloth. Pages xvi+665. 13x19.5. 1931. Messrs. Blackie and Son, Ltd., 17 Stanhope Street, Glasgow, C. 4 England. Price 15 shilling.

Biology Notebook by W. H. D. Meier, Head of the Department of Biology, State Teachers College, Farmingham, Massachusetts and Dorothy Meier, Instructor, Department of Biology, Hunter College, New York City. Paper. 10 units. 160 pages. 19x26.5 cm. 1931. Ginn and Company, Number 15 Ashburton Place, Boston, Mass. Price 72 cents.

The First Year of Chemistry by John C. Hessler, Professor of Chemistry, Knox College. Cloth. Pages xii+580. 13.5x19.5 cm. 1931. Benj. H. Sanborn and Company, 221 East 20th Street, Chicago, Illinois.

Earth Features and Their Meaning, An Introduction to Geology by William Herbert Hobbs, Professor of Geology in the University of Michigan. Second Edition Revised and Enlarged. Cloth. Pages xxxvii+517. 14x21.5 cm. 1931. The Macmillan Company, 60 Fifth Avenue, New York. Price $4.50.

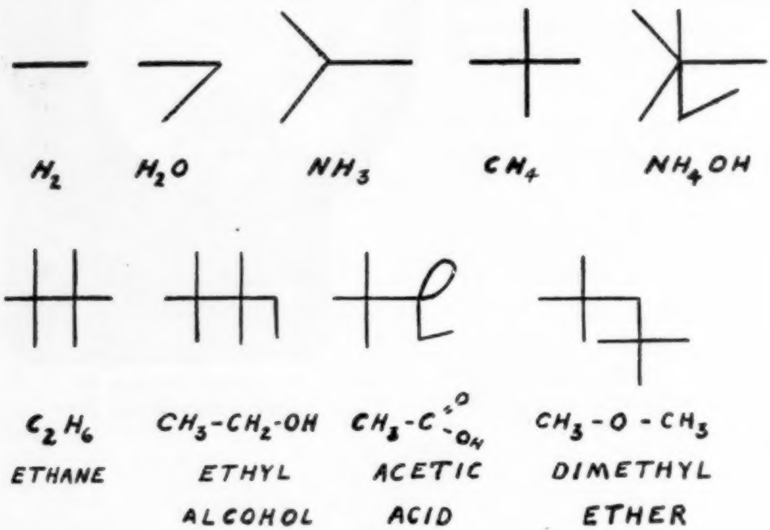
MAGNET HAS NO ATTRACTION FOR HOT IRON.

Although more than 300 years ago scientists knew that a red hot piece of iron is not attracted by a magnet, in the intervening years they have learned little more about the effect of heat on magnetic properties of metals. One of the latest researches in this subject was reported before the American Society for Steel Treating by Raymond L. Sanford, of the U. S. Bureau of Standards, Washington.

Mr. Sanford has found that heating speeds up magnetization at first, but later, as a piece of iron becomes more thoroughly magnetized, it slows down the process. In fact, there is a definite temperature beyond which it is impossible to make a piece of iron respond to magnetism. This temperature was determined by Mr. Sanford's tests to be about 1490 degrees Fahrenheit.—*Science Service.*

Structure Symbols of Organic Compounds by Ingo W. D. Hackh, of San Francisco. Author of "A Chemical Dictionary" and "Chemical Reactions and Their Equations." Cloth. Pages viii+139. 13x20 cm. 1931. P. Blakiston's Son and Company, Inc., 1012 Walnut Street, Philadelphia, Pa. Price $2.50.

This book is an interesting diversion and help to the student and teacher of Organic Chemistry. The recent theories of valence electrons are applied to the study of organic compounds. The relationship between structural, polarity, and electronic formulae are clearly shown. The structure symbol is a shorthand scheme of writing structural formulae. Each molecule is represented by a symbol; the atoms of which are indicated not by their chemical symbols, but by points situated at the ends or the junction of the lines which constitute the structure symbol. (See upper line of the figure below.)



A straight line represents a single bond or a pair of electrons shared in common by two atoms; two curved lines represent a double bond or two pairs of electrons held in common; and two curved and a straight line is a triple bond or three pairs of electrons shared by two atoms. In writing structure symbols we omit the chemical symbols of H, O, N, and C as these elements are indicated by lines; thus

Hydrogen a point from which one line radiates.

Oxygen a point from which two lines radiate; that is where two lines form an angle.

Nitrogen a point where three (or five) lines meet.

Carbon a point where four lines meet.

All other elements are indicated by the usual chemical symbols.

With these simple rules in mind structure symbols for practically all organic compounds can be written. The lower line of the figures shows a few of the simpler typical symbols.

The author claims for this scheme of notation superiority over the ordinary structural forms because of:

Exactness. Each symbol represents *one* definite compound of a definite arrangement. Isomeric, tautomeric and stereo-isomeric compounds can be readily distinguished.

Compactness. These symbols are in fact skeletons of the ordinary

graphic formulae and can when mastered be used in taking notes.

Accuracy. The student can easily check the correctness of the formula since the correct number and kind of atoms can not be recorded unless all the bonds are satisfied.

Simplicity. The average student according to the author can master the scheme in a half hour of careful study.

The little volume closes with a long list of 991 structure symbols with their names and molecular formulas, also a list of thirty electronic structure symbols. It is rather fascinating to look down the list of these hieroglyphic appearing symbols and test your ability of identifying the complex organic compounds.

M. I. Meyer.

Algebra for Today, Second Course, by William Betz, Vice-Principal of the East High School and Specialist in Mathematics for the Public Schools of Rochester, New York. Pages x+502. 14x19.5x2.5 cm. 1931. Ginn and Company, Chicago.

This book, as part of the title indicates, is the author's Second Course and carries the basic idea that algebra can and should be more "meaningful" and more easily understood by young pupils. From the Preface we note the following:

"The entire course is consciously built around three major types of work, namely, (1) the essential technique of algebra; (2) the functional core of algebra, comprising the formula, the equation, and the graph; and (3) the solution of problems."

The organization of the work is on the unit plan. The solving of many problems is carried out in detail to facilitate the work for the pupils. The graph is used when it has a function and receives the treatment necessary to make clear its proper use. It is not confined to one chapter. Much attention is given to "worthwhile applications" of mathematics. The "cultural importance of mathematics" is also stressed, and accomplished by means of illustrations and adequate quotations throughout the text. Quoting again, we have:

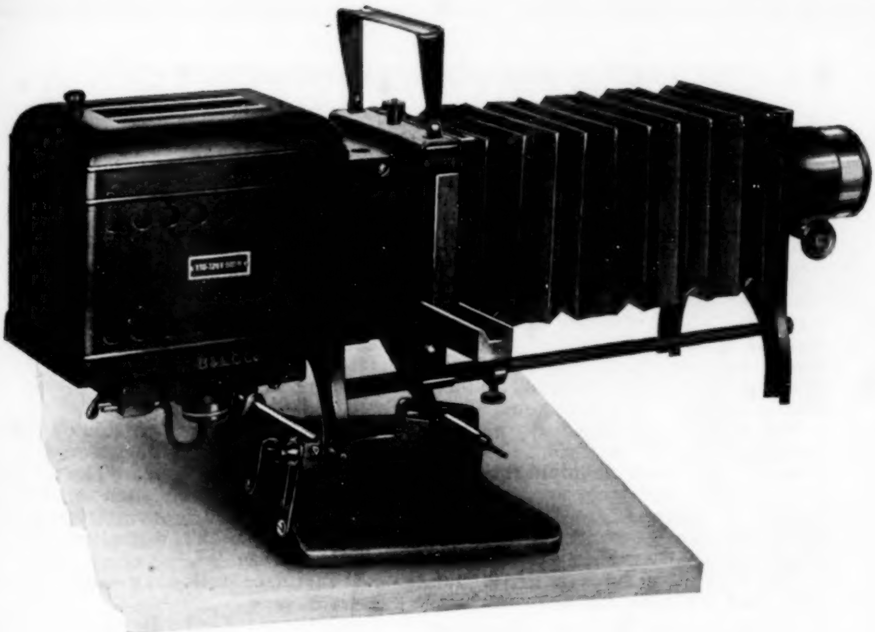
"The explanations and necessary theoretical discussions are not only unusually complete, but aim at the utmost simplicity consistent with scientific accuracy."

The text is so arranged that it may be used to meet a minimum or maximum requirement, or for a half year or full year course.

Joseph J. Urbancek.

Plane Gometry, by Frank M. Morgan, Ph.D, Director of Clark School (College Preparatory), Hanover, New Hampshire; formerly Assistant Professor of Mathematics, Darthmouth College, Hanover, New Hampshire, and John A. Foberg, A.M., Head of the Department of Mathematics, State Teachers College, California, Pennsylvania; formerly Director of Mathematics, State Department of Public Instruction, Pennsylvania, and W. E. Breckenridge, Ph.D., Head of the Department of Mathematics, Stuyvesant High School, New York City. Pages xi+436. 14x19.5x2.5 cm. 1931. Houghton Mifflin Company, Chicago.

Much emphasis is placed by the authors on preparing the student for the solution of originals and the book is written with that as one of the important objectives. The standard propositions are grouped and graded. The originals are skillfully placed and also graded. Groups of exercises are arranged with a view of linking together the major ideas of proven theorems that preceded. Numerous applied problems suitable for use with high school students are included. These also are classified and arranged to assist the instructor who may use them when needed for the various forms of motivation and illustrations he may desire. Illustrations and drawings are numerous throughout the book. Very often these are in the form of graduated steps, each in order, until the construction is completed. To the reviewer, at least, this is a new and novel method and appears



to be a device that will aid the pupils materially. At various places, when the material permits, there are some interesting tests of the true-false, completion, and multiple-choice types.

Joseph J. Urbancek.

Plane and Spherical Trigonometry. By R. D. Carmicheal and E. R. Smith. Ginn and Co. 1930. 198 pp.

A quotation from the preface of this book will almost immediately describe this text. "There is very little room for novelty in preparing a text book for an introductory course in trigonometry. The materials and methods are fairly well standardized." This book is a very conventional treatment of trigonometry beginning in the traditional manner with the measurement of angles and ending of course with a chapter on the trigonometric identities.

The authors introduce all the new concepts in the abstract fashion customary to the traditional mathematical texts. The text does not contain any work involving or even mention the slide rule. The authors have not incorporated in this book the usual tables such as Tables of Powers and Roots, Logarithms, Natural Trigonometric Functions, and Logarithmic Functions, which necessitates the student obtaining another book containing these essential tables.

The text does have a great number of exercises following each topic and contains the answers to the exercises.

G. L. Royce.

Hand Book of Chemistry & Physics by Charles D. Hodgman, M. S., Associate Professor of Physics at Case School of Applied Science and Norbert A. Lange, Ph.D., Assistant Professor of Organic Chemistry at Case School of Applied Science. Sixteenth Edition pp. xiii+1545. 12x17x4 cm. A few figures. Leatherette. 1931. Price $5 list. Special price to students in the U. S. $2.75, in foreign countries $3. Chemical Rubber Publishing Co.

Every science teacher is acquainted with this indispensable handbook. Small in size but with thousands of useful numerical values in physics and chemistry. Over 100 more pages of material than the last edition. Among the new tables are, Abbreviations, Characteristics of vacuum tubes, Lowering of Freezing Point of Aqueous Solutions. Natural Trigonometric Functions for decimal fractions of a degree. Physical Properties of Woods, Reduction of Barometer Readings to Sea Level. The collection of units and conversion factors has been completely revised and very much extended. The section devoted to definitions and formulæ has been rearranged and a large amount of information added including the dimensional formulæ of physical quantities. Changes in the accepted value of the atomic weights of several elements have necessitated extensive revision. The tables of gravimetric factors has been completly recomputed and other material involving molecular or atomic weights made to conform to the new values. Many other important sections have been completely revised.

Science teachers should know that the publishers frequently make very considerable concessions on the price of older editions as long as any are in stock and high school pupils will find these older editions excellent for their purposes and within reach of their purses.

Frank B. Wade.

A History of Chemistry by F. J Moore, Late Professor of Organic Chemistry in the Massachusetts Institute of Technology, Revision prepared by William T. Hall, Associate Professor of Analytical Chemistry in the Massachusetts Institute of Technology. Second Edition. pp. xxiii+324. 15x21x3 cm. Many plates. Cloth. 1931. $3. McGraw-Hill Book Co., Inc.

Those who are acquainted with the first edition of this History already know of its excellence. Prof. Hall has added much to it in

his revision. A brief biography of Prof. Moore is furnished together with his portrait. The order of treatment is lagely chronological, the development of the science being traced together with the biographies of the men who helped develop it. As twelve years have passed since the first edition was published the new edition has brief biographies of the brilliant chemists who have passed away during that time. Some changes have been made in the light of recently discovered facts. In view of the revival of interest in the history of chemistry in recent years as evidenced by the many historical sketches in the Journal of Chemical Education, this revised edition is quite timely. Frank B. Wade.

Qualitative Chemical Analysis, From the Standpoint of the Laws of Equilibrium and the Ionization theory by Louis J. Curtman, Associate Professor of Chemistry in charge of the Division of Qualitative Analysis, The City College of New York. Cloth. Pages x+539. 14x21.5 cm. 1931. Macmillan Company, 60 Fifth Avenue, New York. Price $4.00.

A text book and work manual for college classes of qualitative analysis. The book is divided into five parts.

Part I, Theory and Special Apparatus. Thoroughly modern stressing the newer developments of physical chemistry in their applications to the principles of qualitative analysis. Type problems are given on solubility product, degree of hydrolysis, and hydrogen ion concentration followed by diversified problems for the student with answers.

Part II, The Metal Ions, describes briefly the occurrence and properties of each of the metals in qualitative analysis with a rather complete list of possible reactions that might be used for tests. Werner's coordination number theory is used to explain the cupric ammonia and cobalt complex ions.

Part III, Calculations, type problems involving solutions by percentage weight of solute, and normal solutions of the acidimetry and oxidation and reduction type.

Part IV, Laboratory Work. Qualitative Analysis, preparatory work involving test tube tests illustrative of the reactions that are later used in the systematic analysis of the metallic ions. A scheme of systematic analysis for the metallic ions with many notes concerning the difficulties encountered by the average student. This is followed by test tube tests for the common acid radicals and a scheme for their detection.

Some of the tests described are, magnesium uranium acetate for sodium, zirconium oxychloride for phosphates, diphenylcarbazide for chromates, and the sodium nitroprusside test for the sulfide ion.

Part V, The Acids or Anions. Describes tests for the various acid radicals and the manipulation of metallic analysis in the presence of interfering agents such as phosphates and organic matter. A detailed scheme for detection of acid radicals of the more difficult type, metals in alloys and acid radicals and metallic ions in difficult soluble mixtures.

Appendix, lists the physical constants of inorganic compounds ordinarily found in hand books, also gives detailed instructions for the preparation of solutions. A table of logarithms is printed to facilitate problem work.

Certain of the newer facts of inorganic chemistry that might be of interest are, a water solution of hydrogen fluoride contains only H F and H_6F_6 as molecular species of the hydrogen fluoride. The bleaching of iron stains by an oxalate is due to the formation of the complex ion $Fe(C_2O_4)_3$ — — — Platinum dissolves in aqua regia forming the complex ion $PtCl_6$ — — Silver cyanide is $Ag(Ag(CN)_2$.

Two interesting tricks of the trade that were noted are, the use of a graphite pencil point for flame tests. Utilization of a cloth sup-

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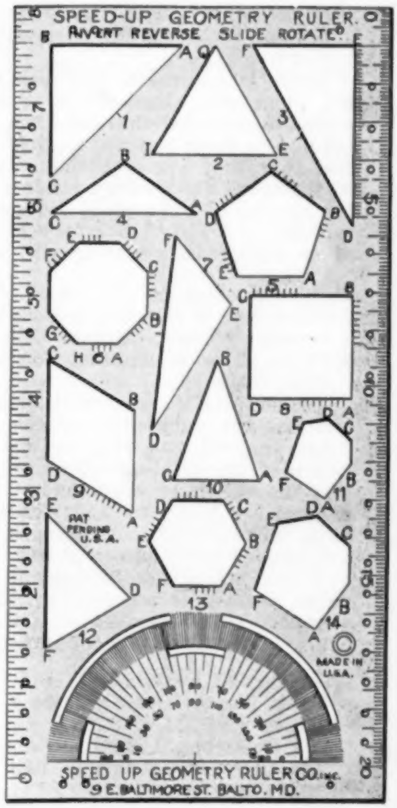

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Very few typographical errors were noted. The theory is modern and is applied consistently in the discussion of the laboratory technique. The directions are complete and easily followed. It should prove a valuable text in qualitative analysis and an excellent book to allow the more proficient high school student to pursue for extra time work. W. H. McLain.

Laboratory Guide for College Zoology by Robert W. Hegner, Professor of Protozoology in The Johns Hopkins University, School of Hygiene and Public Health. Cloth. Pages viii+75. 14x21.5 cm. 1931. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.00.

There is a demand for such a Laboratory Guide. The directions are clear and concise, the questions are thought-provoking. The author has stated that field trips in which the various types may be studied in their natural environment are helpful, some teachers will feel that they are essential. There is enough material in this book to stimulate the zoology student to do some real thinking. Much of the success of the zoology student depends upon the proper use of the laboratory. This laboratory guide supplemented by the personality of an enthusiastic teacher will help. J. W. H.

College Zoology by Robert W. Hegner, Professor of Protozoology in the School of Hygiene and Public Health of the Johns Hopkins University. Third Edition. Cloth. Pages xxiii+713. 14x21 5 cm. 1931. The Macmillan Company, 60 Fifth Avenue, New York. Price $3.50.

Teachers of Zoology or Biology in High Schools and Colleges will welcome the publication of the Third Edition of this text first published in 1912 and used by many students now teaching. The general plan has not been altered, but changes in keeping with new facts and theories have been made. Since the last edition in 1926 a new chapter on Heredity and Genetics has been added. Other sections have been revised and enlarged. The clear, well chosen illustrations are labeled with names at the end of guide lines. The advantages of a text which uses thoroughly discussed types, as examples of the group studies, is accepted by the author and they seem truly representative. This revised edition deserves a place in the reference library of the High School Biology teacher. J. W. H.

A Manual of Experiments and Projects in Physics by H. Clyde Krenerick, North Division High School, Milwaukee, Wisconsin. Paper. Pages vii+184. 13x18.5 cm. 1931. D. C. Heath and Company, 285 Columbus Avenue, Boston, Massachusetts. Price 84 cents.

This manual consists of two parts or sections. The first consists of sixty-four experiments of the usual type but designed so that the average student may complete his experimental work, make the necessary computations, and have it approved in a fifty minute period. Each experiment has an optional part for the rapid students. A half-tone photograph showing the set-up accompanies each experiment, and a tabular form for recording data and results is given.

In general the experiments are of the usual type. The few exceptions are experiments on various phases of automobile mechanics such as Horsepower of Automobile, Power and Torque Curves, Automobile Road Thrust, and Automobile Electric Circuits.

The second part, comprising about one-third of the book consists of "projects." These projects are merely more elaborate experiments, requiring much more apparatus than many schools can house or afford, but they are very desirable for the stronger students, especially those inclined toward technical studies.

The provision for differences in student ability, the adaptation for simple and inexpensive apparatus so that each student may work alone, definite directions for performing each experiment, and selection of experiments which emphasize fundamental physical concepts and principles are the outstanding features of the manual. The long secondary school experience of the author and the rigorous trial given all these experiments before publication especially commend them.

G. W. W.

A Laboratory Course in Everyday Physics by Carleton John Lynde, Ph.D. Teachers College, Columbia University, New York City Cloth. Pages xvii + 205. 12.5x19 cm. 1931. The Macmillan Company, 60 Fifth Avenue, New York. Price $1.00.

This manual consists of forty-nine experiments of the standard type designed to satisfy the College Entrance Board, and twenty-five "practical tests of everyday appliances." The first group contains the usual experiments on density, machines, specific heat, resistance, etc., but many of these include in addition to the regular experiment, exercises on related topics or applications of the principle studied; e. g. the Boyle's law experiment contains an exercise on fire extinguishers and one on vacuum cleaners. The experiments in general call for large apparatus rather than the usual standard laboratory equipment. Specific gravity specimens weigh two or three pounds, 3-quart pails are used for calorimeters. Many of the experiments emphasize household applications of physical laws and require expensive apparatus. This is especially true of the twenty-five practical tests, but the laboratory with standard equipment will need some extra apparatus to fit the minimum course as outlined by this manual. Many of the features are highly commendable and no doubt will promote interest in the physics course. We recommend this manual to schools where there is a lack of interest in physics.

G. W. W.

SENSITIVE GALVANOMETERS FOR THE HIGH SCHOOL LABORATORY.

By Geo. P. Unseld, *Salt Lake City.*

When we actually try out a new method, the results are sometimes quite different from what we had expected. If one were asked to purchase sensitive galvanometers with telescopes and scales for use with high school pupils he would probably reply that such instruments are entirely unsuited for this work. Yet, with us, this has certainly not proved to be the case.

Ten years ago the writer placed four such galvanometers in his laboratory and a few years later two more were added. In the mean time these instruments have been used by a number of classes, the number of pupils involved being well over two thousand. They have given most excellent satisfaction and we regard them as a most valuable part of our equipment. Occasionally, perhaps two or three times a year, a suspension needs to be replaced, and, so far, three crosshairs have been broken.

These instruments cannot be used on wooden tables because of vibration, but they give no trouble when placed on brackets attached to the walls of the building. In our laboratory a bench two feet wide passes along the wall beneath the instruments, which protects them to a large extent. Wires are brought down from the instruments to this bench and the pupils are instructed to leave the instruments alone and to call on the instructor for adjustments. Occasionally a head strikes a telescope or some disobedient pupil trys

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to level the instrument or to change the focus and hence they need to be adjusted quite often. But, considering everything, we have found these most worth-while instruments.

A most obvious experiment is to compare the capacities of condensers by means of the ballistic galvanometer. We have found an old "B-battery eliminator" very useful for charging the condensers. By varying the voltages used the values of the deflections may be made nearly equal, even when widely different capacities are used.

Another simple experiment is to make a graph of the current produced by a thermocouple of only one iron and one copper wire as the temperature of the junction is changed. When placed in boiling water the deflection is near the end of the scale and an acceptable set of data is easily obtained.

Another experiment which we have used is to find the resistance of a pencil mark. The accessories necessary are a high resistance of the order of 50,000 ohms and a resistance box for use as a shunt. The constant of the galvanometer is given the pupil and from this and the resistance he calculates the potential of the cell. Then, knowing the potential and the current he can find the resistance of the pencil mark.

Another experiment is to find the resistance of a piece of heavy copper wire, using the latter as a shunt and having an ammeter in the circuit. The result is checked by calculating the resistance from the dimensions of the wire and the specific resistance of copper.

Other experiments can be designed, such as drawing calibration curves using the instrument as a voltmeter or as an ammeter. In the former case a megohm "grid-lead" makes a suitable high resistance.

For a few of the better members of the classes, especially the boys who have had experience in amateur radio telegraphy, we have an experiment wherein one of these galvenometers is used ballistically in connection with a standard solenoid for finding the number of unit poles present in a permanent magnet. The theory involved in this experiment is obviously too difficult for many of the pupils.

A REMARKABLE NEW PROTOELECTRIC CELL.

For many years photoelectric cells have been serving an extremely useful mission in experimental and industrial work in controlling the operation of apparatus and equipment, in controlling various processes and in many counting operations. A number of different type cells have been available for experimental, commercial and scientific applications, each type, however, had its own inherent limitations in operating performance or had to be used in conjunction with expensive auxiliary equipment.

The discovery of an ideal type of photoelectric cell has been the subject of continual scientific research. To be of the most practical value the cell sought after should combine all the good qualities of existing cells with none of their shortcomings or limitations. Such a cell would be truly ideal but its successful attainment has been a baffling scientific problem.

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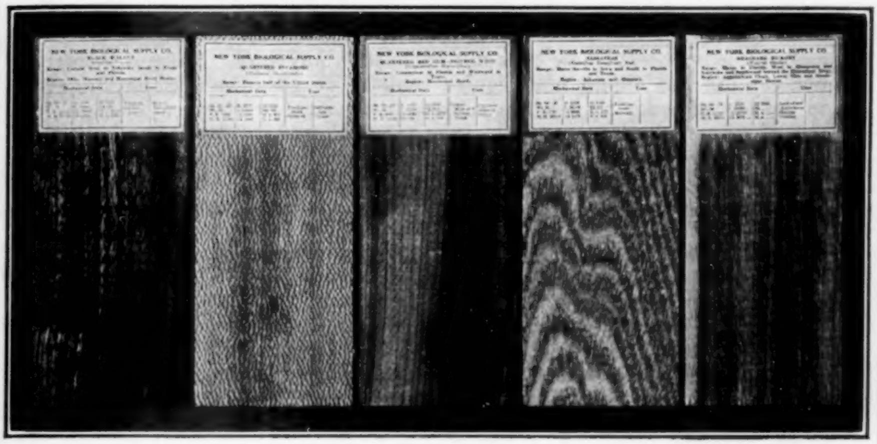

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Elder, Box
Elm, Rock
Elm, Soft
Gum, Plain Red
Gum, Plain Red (Figured Wood)
Gum, Plain Sap
Gum, Plain Tupelo
Gum, Quartered Red
Gum, Quartered Red (Figured Wood)
Gum, Quartered Sap
Hackberry
Hickory, Shagbark
Holly
Locust, Honey
Magnolia, Evergreen
Maple, Hard
Maple, Red
Oak, Plain Red (Eastern)
Oak, Plain Red (Southern)
Oak, Plain White (Southern)
Oak, Quartered Red (Eastern)
Oak, Quartered Red (Southern)
Oak, Quartered White (Eastern)
Oak, Quartered White (Southern)
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its character, this cell employs a highly light sensitive disc which transforms light energy directly into electrical energy without the use of any auxiliary voltage whatsoever. Its response to light variations is instantaneous and sufficient current is developed to directly operate Weston relays without the use of auxiliary apparatus or any battery. It delivers about one microampere per foot-candle of light intensity. When exposed to direct sunlight the output is approximately 5 milliamperes. The cell resistance varies from about 1500 ohms for 10 foot-candles light intensity to about 300 ohms for 240 foot-candles intensity.

As far as is known, the life of the cell is practically unlimited and a continuous current flow does not harm it in any way. Since it does not contain any liquid nor require vacuum or gas, there is nothing to get out of order as it is not subject to physical or chemical change and it has a constant output. It can be exposed to direct sunlight without deterioration, has no dark current since its energy is derived directly and only from light; no drifting, hence no circuit adjustments are necessary; no fatigue and it is non-microphonic.

TELEVISION TO MAKE ECLIPSES VISIBLE OVER ENTIRE COUNTRY.

The whole world may some day be able to see the sun in total eclipse through the medium of television, Prof. Elihu Thomson, American electrical pioneer, predicted at the Faraday Centennial.

"Though direct observation of a total eclipse is necessarily confined to the dark tract of the moon's shadow, television may bring us from a distance images of the sun in eclipse," Prof. Thomson said.

This prediction may be fulfilled next August, when an eclipse cuts across New England; but technical development of television broadcasting may not then be sufficiently advanced.

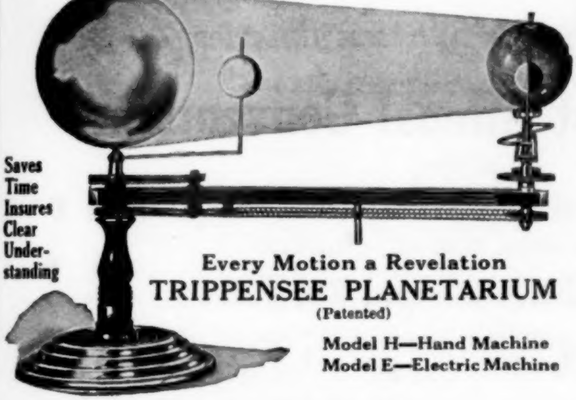
Even television is an outgrowth of Faraday's epochal work, Prof. Thomson said; and the Marchese Marconi, inventor of wireless, said, "In a sense wireless dates from the discovery made by Faraday that it is not necessary for two electrical circuits to be in physical contact in order that electric energy might pass across the small space between them."

Marconi expressed as his opinion, "Television is now beginning to emerge from the laboratory stage."

Marconi declared that radio, especially since the advent of short waves, has become the worldwide voice of all nations, promoting peace through interchange of knowledge amongst peoples.—*Science Service*

COLORED FLOWER JUICES USED TO TEST ACIDS.

Colored flower-saps, extracted from the petals of a number of species, are being used to test the degree of acidity or alkalinity of chemical solutions, by Dr. E. P. Smith, a British botanist. It has long been known, in a casual way, that some blue flowers dropped into a weak acid solution will turn pink, but hitherto an exact measurement of their value as litmus-like indicators has not been undertaken. Dr. Smith has determined the color-values of a number of saps, ranging through red, blue, violet and purple, in the presence of a wide range of acidities and alkalinities. Among the flowers he has used are species of anemone, cineraria, hibiscus, primrose, tulip and morning-glory.



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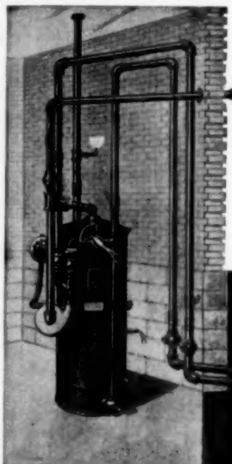

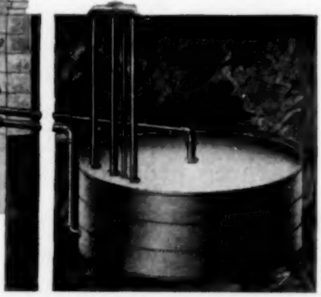

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This is a meeting all members and friends of the C. A. S. and M. T. will want to attend. Every minute of the two days is packed with inspiring addresses, educating discussions, interesting lectures, spectacular demonstrations and delightful visits with friends.

FRIDAY MORNING

A veteran of our Mathematics Section, Professor H. E. Slaught, of The University of Chicago, has prepared a special treat for us. He is the one man who can make mathematics interesting to everyone. Hear his sound philosophy embellished by rich humor and keen wit early Friday morning on "Number—The Language of Science."

Then we have another man from the Midway University who is new to our Association—a geologist who can translate the wonders of research into language all can appreciate. Dr. Carey Croneis' popular lecture on "The Geologic Path of Life" (illustrated) will also be a feature of the Friday morning program.

FRIDAY AFTERNOON

Friday afternoon is Section time. Watch for the Year Book with announcements. Among the speakers are Dr. Henry Baldwin Ward, the noted zoologist of Illinois University, who will discuss Conservation. This topic should appeal to every nature lover and to every scientist. Dr. N. Henry Black of Harvard University, recently back from a year of observation and study in England, will bring a message to the chemists. Dr. W. A. Granville, whose textbook in calculus is known everywhere, will discuss the Fourth Dimension for the mathematics section. Mr. Wm. N. Parker, Engineer of the Western Television Corporation, will demonstrate Television to the physics group. The Chemistry of Oil Refining will be dis-

cussed by Mr. T. H. Rogers, Assistant Director of Research of the Standard Oil Company. Mr. Geo. M. Baker of Rand McNally and Co. will lead a discussion on Cartographical Material.

FRIDAY EVENING

Friday evening is the great frolic of the convention. Attend the annual dinner for two hours of festivity and fun, then go to the Auditorium for a demonstration-lecture that has entertained and astonished audiences in all the great universities and scientific societies of the country. Dr. William Braid White, Director of Acoustic Research, American Steel and Wire Company, will produce music and show its physical forms; he will show noises without disturbing the tympanum.

SATURDAY MORNING

On Saturday a real treat is in store. The Adler Planetarium and Astronomical Museum, the only institution of its kind in America, will be visited. Dr. Philip Fox, Director of the Planetarium, and noted astronomer and lecturer, will explain the operation of the planetarium and show the wonders of starland. Next will come a series of Guide-lectures at Field Museum of Natural History. Members of the Museum Staff who have made and assembled the collections will conduct groups through sections of the museum, lecturing as they pass from one exhibit to another.

No member should miss this convention. Each one should bring a new member. The officers who have arranged this program are confident you will not be disappointed.

SPECIAL ANNOUNCEMENT.

In some sections of the country the financial depression has stopped payment of teachers' salaries. If you have not received your salary checks this fall, that need not prevent you from attending the Annual Meeting. The Executive Committee has decreed that you may give your promise to pay your membership fee when you get your salary check and you will receive a deferred payment membership card which will entitle you to attend the Annual Meeting. Send the Treasurer a pre-dated check for your dues or, if you are uncertain when your salary will be paid, send him your promise and you will receive credentials in either case.

PROPOSED AMENDMENTS.

By order of the Board of Directors of the Central Association of Science and Mathematics Teachers, Inc. the President appointed a committee to study the By-Laws of the Association and recommend changes. This committee was appointed and submitted the report which is published below. All members are requested to study these proposed amendments and to attend the 1931 Annual Business Meeting Saturday, November 28, prepared to vote for or against their adoption.

Proposed Amendments to the By-Laws of the Central Association of Science and Mathematics Teachers.

The following sections shall read as follows:

Article 2, Section 3. Twenty-five members present at any regular meeting shall constitute a quorum.

Article 2, Section 7, Proxies. All members entitled to vote may cast their votes in person or through a duly accredited proxy.

Article 3, Section 4, (c). Secretary. The Secretary shall keep all the records, minutes of all meetings and shall prepare and submit a complete report of the annual meeting to the editor of the journal by December 31st following the meeting. He shall have charge of the permanent offices and manage the affairs of the Association under the direction of the Executive Committee.

Article 3, Section 4, (d). Treasurer. The Treasurer shall collect all dues and hold all moneys and keep a record of all receipts and disbursements. He shall give a detailed report at each meeting of the Association. He shall pay out funds on the order of the Board of Directors and the Executive Committee.

Article 3, Section 4, (e). Editor and Business Manager. The Editor and the Business Manager of the journal shall be elected by the Board of Directors. Their term of office shall be indeterminate at the pleasure of the Board of Directors.

Article 3, Section 4, (f). Fiscal Year. The Fiscal year shall be from July 1st to June 30th.

Article 6. Amendments. The By-Laws may be amended by a two-thirds (⅔) vote of the regular members present at any regular meeting of the Association or at any special meeting of the Association called for the purpose of voting on such amendment provided the proposed amendment has been published in two successive issues of School Science and Mathematics.

Clarence L. Holtzman, *Chairman.*
Charles M. Turton,
Walter G. Gingery.